

Biochemistry

Final Revision

1st year medical students

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VISIT...

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Caliente.COM

اللهم

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يفقه قلبي



All Enzymes of the Molecular Biology

Process	Enzyme	Function	Description
Replication	Prokaryotes	Primase	Synthesis of RNA primer (5 RN)
		DNA polymerase I	Removal of RNA primers & filling of gaps by deoxyribonucleotides
		DNA polymerase II	DNA repair
		DNA polymerase III	Main enzyme of replication for leading & lagging strands e` proof reading
	Eukaryotes	DNA polymerase α	Binds e` primase and form a complex that forms RNA primer (10 RN) & short stretch of DNA
		DNA polymerase β	DNA repair enzyme
		DNA polymerase γ	Replicate mitochondrial DNA
		DNA polymerase δ	Main enzyme of replication for lagging strand & fills the gaps by DNA
		DNA polymerase ϵ	Replicates the leading strand
		Rnase H	Removal of RNA primers
		Telomerase	- Prevents chromosomal recombination - Binds to 3' of template strand elongating it (prevents shortening of the telomere)
	Pro & Eu	Helicase	Separates the 2 DNA strands
		Ligase	Connects the DNA fragments together
		Topoisomerase I	Removes positive supercoil (No ATP)
		Topoisomerase II (Gyrase in bacteria)	Removes +ve supercoil (Needs ATP)
Transcription	Pro	RNA polymerase	Transcription in prokaryotes
	Eukaryotes	RNA polymerase I	Transcribes 18 S, 5.8 S & 28 S rRNA genes
		RNA polymerase II	Transcribes mRNA & snRNA
		RNA polymerase III	Transcribes tRNA, 5 S rRNA & 7 S RNA
		Poly A polymerase	Adds poly A tail to the 3' end of mRNA
		Splicesomes	Cuts the introns & splices the exons of mRNA
Translation		Aminoacyl tRNA synthetase	Binds the aa to the acceptor arm at 3' end of its specific tRNA
		Peptidyl transferase	Forms peptide bonds between the amino acids carried on tRNAs during translation
Apoptosis		Caspases	Proteolysis to Ptns of the cell Fragmentation of the DNA of the cell
Recombinant DNA techn.		Restriction Endonucleases i.e EcoR I & Mst II	Restrict viral growth in bacteria Used in recombinant DNA technology
		Reverse transcriptase	Synthesis a DNA strand complementary to mRNA (cDNA)
		Taq polymerase	DNA polymerase used in PCR
Miscellaneous		3' Exonuclease	Cuts nucleic acid at the 3' end
		5' Exonuclease	Cuts nucleic acid at 5' end
		Endonucleases	Cuts nucleic acid from the middle

By Dr / A. M.



Final Exam Revision

1. Define (what is meant by)

1. pH
Negative value of $\log [H^+]$
2. pOH
Negative value of $\log [OH^-]$
3. Acids
Substances w^h Increase $[H^+]$ i.e Proton Donors
4. Bases
Substances w^h Increase $[OH^-]$ i.e Proton acceptors
5. Buffers
Solutions w^h resist changes in their pH when moderate amounts of acids or bases are added
6. Physiological buffers
Buffers that keep the pH of the blood & body fluids around 7.4
7. pKa
pH at which the concentration of the dissociated form (conjugate base) equals that of the undissociated form (acid)
8. Acidosis :
 $\downarrow$ pH less than 7.4 or $\downarrow$ in $BHCO_3 / H_2CO_3$ ratio less than 20 : 1
9. Alkalosis
 $\uparrow$ pH more than 7.4 or $\uparrow$ in $BHCO_3 / H_2CO_3$ ratio more than 20 : 1
10. Molar solution
Contain the molecular weight in grams dissolved in 1 litre of water
11. Normal solution
Contains the equivalent weight in grams dissolved in 1 litre of water
12. Molality
No. of moles of solute dissolved in 1 kg of solvent (mol/kg , molal or m)
13. Diffusion
Passage of solute molecules from areas of higher concentrations to areas of lower concentrations of solute
14. Osmosis
Passage of Solvent molecules through a semi permeable membrane from a solution of lower concentration to a solution of higher concentration
15. Osmotic Pressure [OP.]
The hydrostatic Pressure needed to prevent Osmosis
16. Osmole
No. of impermeable particles dissolved in a solution regardless of charge



17. Osmolarity

Measure of the osmoles of solute per liter of solution (depend on the No. not nature of solute)

18. Iso-osmotic solutions

Solutions having the same OP

19. Osmolality

Measure of osmoles of solute per kilogram of solvent

20. Tonicity

Measure of OP that a substance can exert across a cell membrane compared to that of blood plasma w^h is 290 mosm/L

21. Isotonic Solutions

Have OP. Similar to that of body fluids (0.9 g/dl NaCl)

22. Hypertonic Solutions

Have OP. Higher than that of body fluids

23. Hypotonic Solutions

Have OP. Lower than that of body fluids

24. Viscosity

Resistance offered by a solution to flow through a capillary tube

25. Surface tension :

The Force by w^h the surface molecules are held together

26. Hydrotropy :

The ability to dissolve water insoluble substances in water without change in their chemical nature

27. Adsorption

Attraction of small particle to the surface of large particle

28. Elution

Removal of adsorbed particles from the surface of an adsorbent using another solvent

29. Tyndall effect of colloidal solution

If a beam of light is passed through a colloidal solution, colloidal particles appear as light spots in a dark background under ultra microscope due to reflection

30. Electrophoresis

Migration in electric field

31. Metabolic water

Water produced inside the body due to oxidation of food or stored fat

32. Monosaccharide

CHO formed only formed of 1 sugar unit (can't be hydrolyzed)

33. Disaccharides

CHO formed of 2 sugar units

34. Oligosaccharide

CHO formed of 3 – 10 sugar units



- 35. Polysaccharide**
CHO formed of more than 10 sugar units
- 36. Optical activity**
Ability of substance to rotate PPL (Plane Polarized Light) to an angle measured by polarimeter
- 37. Asymmetric carbon atom**
Carbon atom attached to 4 different atoms or groups
- 38. Optical isomers**
Compounds having the same molecular weight, the same Structural formula but differ in the orientation of H or OH around 1 or more carbon atom
- 39. Epimers**
Optical isomers having more than 1 asymmetric carbons all are the same only 1 is different
- 40. Anomers**
The α & β form of any sugar
- 41. Enantiomers**
The D & L forms of any sugars & they are mirror images
- 42. Racemic mixture**
Mixture containing equal amounts of both enantiomers (50% D-glucose & 50% L-glucose)
- 43. Mesocompound**
Compound containing asymmetric carbon atom but optically inactive, as one half is mirror image for the 2nd half $\rightarrow$ internal compensation of rotation i.e. mucic acid
- 44. Mutarotation**
The spontaneous change in the specific rotation of optically active substance when a fresh solution of this substance is prepared
- 45. Aldose – Ketose Isomers (Functional group Isomerism) :**
Have the same molecular formula but differ in the functional group
- 46. Ester**
Acid + alcohol
- 47. Glycoside**
Product of condensation of the sugar in the ring structure e` alcohol or phenol
- 48. Glycosaminoglycans (GAGs) or mucopolysaccharide**
Heteropolysaccharide formed of uronic acid + aminosugar
- 49. Fatty acids**
Monocarboxylic organic acids mostly have even No. of carbons
- 50. Simple lipids**
Esters of FA e` alcohol
- 51. Rancidity**
Development of bad flavor of oil or fat
- 52. Iodine number**
No. of grams of iodine absorbed by 100 g fat or oil



53. Soap

Alkaline salt of FA

54. Saponification

Alkaline hydrolysis of TAG

55. Waxes

Esters of long chain FAs & long chain alcohols

56. Hardening

Hydrogenation of oils to form solid fat or margarine

57. Eicosanoids

Hormone like substances derived from C₂₀ PUFA i.e. arachidonic & timnodonic

58. Amphoteric properties of aa

The aa in acidic media react as a base & carries +ve charge & in basic media react as an acid & carries -ve charge

59. Primary structure of Ptn.

No. & sequence of amino acids that form the backbone of the polypeptide chain

60. Secondary structure of Ptn.

Folding of the polypeptide chain into α helix or β pleated sheets

61. Tertiary structure of Ptn.

Twisting of the polypeptide chain to form a globular Ptn.

62. Denaturation

Loss of the organization of Ptn & breakdown of secondary, tertiary & quaternary structure

63. Isoelectric point (IEP)

The pH at which the amino acid carries both +ve & -ve charges

64. Zwitterion or Dipolar ion

Amino acid which carries both +ve & -ve charges

65. Salting in

↑ Solubility of Ptn in dilute solutions (by adding salts)

66. Salting out

↓ Solubility (precipitation) of Ptns from its solution by partial or full saturation & salts

67. Heme

Ferrous protoporphyrin IX or III

68. Enzymes

Organic substances act as biocatalysts that increase the rate of chemical reaction

69. Zymogen (Pro-enzyme)

Enzymes secreted in an inactive form (active site masked by polypeptide chain)

70. Km (Michaelis constant)

Substrate concentration that produce $1/2 V_{max}$

71. Competitive inhibitor

Inhibitor is similar to substrate & competes & it for the active site of the enzyme



72. Allosteric inhibitors

Binds to allosteric site → conformational change in active site → less suitable to S

73. Compartmentalization of enzymes

Enzymes belonging to certain metabolic pathway are localized to a certain organelle

74. Covalent modification

Regulation of the enzyme activity by phosphorylation or dephosphorylation

75. Feed back inhibition

The end product of a series of reactions inhibits an enzyme early in the pathway

76. Fluid mosaic pattern

The hydrophobic parts of lipid & Ptn are present towards the core while the hydrophilic

Parts are present towards outside of cell membrane

77. Introns

Non coding sequences on DNA

78. Exons

Coding sequence on DNA

79. Gene

Sequence of a nucleotide on the DNA codes for a certain character

80. Genome

Total genetic information

81. DNA denaturation (melting of the DNA)

Rupture of hydrogen bonds & separation of the 2 DNA strands by heating this accompanied by hyperchromicity

82. DNA renaturation or reannealing

Rebinding of the 2 DNA strand after denaturation

83. Replication

Synthesis of DNA from another DNA strand (template strand)

84. Semiconservative replication

In replication ; the newly formed DNA molecule contains one parent strand & one daughter strand

85. Okazaki fragment

Short fragment of DNA connected to RNA primer

86. Leading strand

DNA strand synthesized continuously during replication

87. Lagging strand

DNA strand synthesized discontinuously during replication

88. Telomeres

Non coding sequence of DNA consists of repeats of TTAGGG

89. Transcription

Synthesis of RNA from DNA



- 90. RNA splicing**
Cutting of the introns & joining the ends of neighboring exons to produce functioning mRNA in eukaryotes
- 91. Capping of the mRNA**
Addition of 7 methyl GTP at the 5' end of the mRNA
- 92. Polyadenylation**
Addition of poly A tail at the 3' end of the mRNA
- 93. mRNA editing**
Changing the coding information of mRNA
- 94. Translation**
Synthesis of protein by the ribosome
- 95. Genetic code**
Correspondance between the codons on the mRNA & the aa
- 96. Synonym codons**
Codons that codes for the same aa
- 97. Inducible genes**
Genes that are negatively regulated by repressors
- 98. Constitutive genes**
Genes whose expression is not regulated
- 99. Operon**
Linear array of genes involved in a metabolic pathway
- 100. Cistron**
The smallest area of genetic expression that codes for the structure of a protein
- 101. Structural genes**
Genes that codes for the product of the operon
- 102. Regulatory gene**
Codes for a specific regulatory protein called repressor
- 103. Repression**
Inhibition of gene expression by binding of a repressor to the operator
- 104. Derepression**
Induction of gene expression by removal of the repressor
- 105. Gene amplification**
Increase of the product of a gene by increasing the No. of copies of this gene
- 106. Gene diminution**
Removal of a gene or genes from the genome i.e., loss of all genes in RBCs
- 107. Enhancers**
Cis acting elements increases the rate of gene expression
- 108. Silencers**
Cis acting elements decrease the rate of gene expression



09. Mutations

Permanent change in the DNA

110. Mis sense mutation

A type of substitution (Point) mutation in which there is permanent change in one nucleotide leads to change of the codon on mRNA leads to change of the aa in the protein product of the gene

111. Non sense mutation

A type of substitution (Point) mutation in which there is permanent change in one nucleotide leads to change of the codon on mRNA & the resulting codon is stop codon UGA , UAG or UAA resulting in premature termination of translation

112. Silent mutation

A type of substitution (Point) mutation in which there is permanent change in one nucleotide leads to change of the codon on mRNA & the resulting codon codes for the same aa so there is no change in the protein product of the gene

113. Cell cycle

Events that lead to completion of cell division and formation of 2 daughter cells

114. Restriction point

Point in the cell cycle (late in G1) at w` the cell become committed to enter S phase & to compete the cell cycle independent of the presence of growth factors

115. Mitosis promoting factors (MPF)

CDK-cyclin complex

116. Apoptosis

Programmed cell death (cell suicide)

117. Restriction Endonucleases

Bacterial endonucleases that protects the host against viral infection

118. PCR (Polymerase Chain Reaction)

In vitro method for amplification of DNA

119. Chimeric DNA or (recombinant DNA)

DNA from 2 different sources

120. DNA denaturation (melting of the DNA)

Rupture of hydrogen bonds & separation of the 2 DNA strands by heating this accompanied by hyperchromicity

121. DNA renaturation or reannealing

Rebinding of the 2 DNA strand after denaturation

122. Epitopes

Parts of an antigen that interact with an antibody molecule or a lymphocyte receptor

123. Frame work region of the Ig

Parts of the variable region that don't contact the antigen directly



124. Valency of the antibody

No. of antigens that the antibody can bind with

2. Mention the hydrolytic products of

1. Maltose

2 molecules of Glucose

2. Sucrose

Glucose + Fructose

3. Lactose

Glucose + Galactose

4. Inulin

Fructose

5. Starch or (Amylose) or (Amylopectin)

Glucose

6. Dextrin

Glucose

7. Glycogen

Glucose

8. Neuraminic acid

Mannosamine + Pyruvic acid

9. Sialic acid (NANA)

Mannosamine + Pyruvic acid + Acetic acid

10. Hyaluronic acid

Glucuronic acid + Acetic acid + glucosamine

11. Chondroitin sulfate

Glucuronic acid + acetic acid + galactosamine + sulfate

12. Dermatan sulfate

Iduronic acid + acetic acid + galactosamine + sulfate

13. Keratan sulfate

Galactose + acetic acid + glucosamine + sulfate

14. Heparin or heparin sulfate

Glucuronic acid + Iduronic acid + glucosamine + sulfate

15. Triacylglycerol (TAG)

Glycerol + 3 Fatty acids

16. Alkaline hydrolysis of triacylglycerol (TAG)

Glycerol + Soap

17. Phosphatidic acid

Glycerol + Saturated FA + Unsaturated FA + Phosphate

18. Lecithin



Glycerol + Saturated FA + Unsaturated FA + Phosphate + Choline

19. Cephalin

Glycerol + Saturated FA + Unsaturated FA + Phosphate + Ethanolamine

20. Lipositol

Glycerol + Saturated FA + Unsaturated FA + Phosphate + Inositol

21. Plasmalogen

Glycerol + Unsaturated Fatty alcohol + Unsaturated FA + Phosphate + Choline

22. Cardiolipin

3 Glycerol + 4 FA + 2 Phosphate

23. Sphingomyelin

Sphingosine + FA + Phosphate + Choline

24. Cerebroside

Sphingosine + FA + Glucose or Galactose

25. Sulfolipid

Sphingosine + FA + Galactose + Sulfate

26. Diacylglycerol

Glycerol + 2 FA

27. Ceramid

Sphingosine + FA

28. Phosphatidyl glycerol

2 Glycerol – SFA – USFA – Phosphate

29. Nucleoside

Nitrogenous base + Pentose

30. Nucleotide

Nitrogenous base + Pentose + Phosphate

31. Adenosine or Guanosine or Inosine or Xanthosine

(Adenine or Guanine or hypoxanthine or Xanthine) + Pentose

32. Thymidine or Uridine or Cytidine

(Thymine or Uracil or Cytosine) + Pentose

33. AMP (Adenylic acid "AA")

Adenine + Ribose + Phosphate

34. GMP (Guanylic acid "GA")

Guanine + Ribose + Phosphate

35. IMP (Inosinic acid "IA")

Hypoxanthine + Ribose + Phosphate

36. XMP (Xanthylic acid "XA")

Xanthine + Ribose + Phosphate

37. TMP (Thymidylic acid "TA")

Thymine + Ribose + Phosphate



- 38. UMP (Uridylic acid "UA")**
Uracil + Ribose + Phosphate
- 39. CMP (Cytidylic acid "CA")**
Cytosine + Ribose + Phosphate
- 40. ADP or GDP or UDP or CDP**
(Adenine or Guanine or Uracil or Cytosine) + Ribose + 2 Phosphate
- 41. ATP or GTP or TTP or UTP or CTP**
(Adenine or Guanine or Thymine or Uracil or Cytosine) + Ribose + 3 Phosphate
- 42. cAMP or cGMP**
(Adenine or Guanine) + Ribose + Phosphate
- 43. dATP or dGTP or dTTP or dCTP**
(Adenine or Guanine or Thymine or Cytosine) + Deoxyribose + 3 Phosphate
- 44. SAM**
Adenine + Ribose + Methionine
- 45. SAH**
Adenine + Ribose + Homocysteine
- 46. PAPS**
Adenosine + Ribose + 2 Phosphate + Sulfate
- 47. CoASH**
Adenine + Ribose + 3 Phosphate + Pantothenic acid (vit B5) + Thioethanolamine
- 48. FMN**
Flavin (vit B2) + Ribitol + Phosphate
- 49. FAD**
Flavin + Adenine + Ribitol + Ribose + 2 Phosphate
- 50. NAD**
Nicotinamide (vit B3) + Adenine + 2 Ribose + 2 Phosphate
- 51. NADP**
Nicotinamide (vit B3) + Adenine + 2 Ribose + 3 Phosphate
- 52. CDP-choline or CDP-ethanolamine**
Cytosine + Ribose + 2 Phosphate + (Choline or Ethanolamine)
- 53. CDP-DAG**
Cytosine + Ribose + 2 Phosphate + Glycerol + 2 FA
- 54. UDP-glucose or UDP-galactose or UDP-glucuronic acid**
Uracil + Ribose + 2 phosphate + (Glucose or Galactose or Glucuronic acid)
- 55. DNA**
Adenine + Guanine + Thymine + Cytosine + Deoxyribose + Phosphate
- 56. RNA**
Adenine + Guanine + Uracil + Cytosine + Ribose + Phosphate



3. Enumerate or Mention

1. Non covalent bonds

Hydrogen bond – ionic interactions – vander Waals forces – hydrophobic interaction

2. Water properties

Thermal – solvent – reactant properties – dissociation & pH

3. Cause of thermal properties of water

Ability to form hydrogen bonds

4. Cause of solvent properties of water

Dipolar structure of water

5. Strong acid & strong base

HCl – NaOH

6. Weak acid & weak base

H_2CO_3 – NH_4OH

7. 1 Respiratory (volatile) & 2 metabolic (fixed) acids

Carbonic acid – phosphoric & sulfuric acids

8. 3 mechanisms for regulation of pH

Buffers – respiration – kidney

9. 2 Methods for composition of buffers

A weak acid & its salt e` strong base - A weak base & its salt e` strong acid

10. Physiological buffers

Bicarbonate - Phosphate - Protein - Hemoglobin buffer system

11. Advantages of bicarbonate buffer system

- Present in higher concentrations than other buffers
- Easily formed at the tissues from CO_2 by Carbonic Anhydrase enzyme
- Easily corrected by respiration; CO_2 is excreted e` expired air at Lungs

12. 1 physiological buffer linked to the kidneys & another 1 linked to the lungs

Phosphate – Bicarbonate buffer system

13. 2 Causes of respiratory acidosis

- Lung disease : ABEP : Asphyxia – Bronchial asthma - Empysema – Pneumonia
- Morphine poisoning

14. 2 Causes of metabolic acidosis

- ↑ Acid production : sever exercise - ↑ Ptn in diet – ketosis in uncontrolled DM
- Loss of base : severe diarrhea

15. 2 Causes of respiratory alkalosis

HFHAM : Hysteria – Fever – High altitudrs – Aspirin poisoning – Meningitis

16. 2 Causes of metabolic alkalosis

Loss of acids : Vomiting & gastric wash - ↑ vegetables in diet – Intake of bases – hypokalemia



17. Biochemical characters in uncompensated respiratory acidosis

PH	PCO ₂	[HCO ₃ ⁻]
↓	↑	Normal

18. Biochemical characters in partially compensated respiratory acidosis

PH	PCO ₂	[HCO ₃ ⁻]
↓	↑	↑

19. Biochemical characters in uncompensated metabolic acidosis

PH	PCO ₂	[HCO ₃ ⁻]
↓	Normal	↓

20. Biochemical characters in partially compensated metabolic acidosis

PH	PCO ₂	[HCO ₃ ⁻]
↓	↓	↓

21. Biochemical characters in uncompensated respiratory alkalosis

PH	PCO ₂	[HCO ₃ ⁻]
↑	↓	Normal

22. Biochemical characters in partially compensated respiratory alkalosis

PH	PCO ₂	[HCO ₃ ⁻]
↑	↓	↓

23. Biochemical characters in un compensated metabolic alkalosis

PH	PCO ₂	[HCO ₃ ⁻]
↑	Normal	↑

24. Biochemical characters in partially compensated metabolic alkalosis

PH	PCO ₂	[HCO ₃ ⁻]
↑	↑	↑

25. Types of solutions

True (crystalloidal) – Colloidal – Suspensions

26. 3 Methods for expression of concentration of solutions

Percent – Molar & normal – Molality

27. 3 Properties of a solution

Diffusion – Osmosis – Surface tension

28. 2 Factors controlling osmotic pressure

Concentration – No. of molecules

29. Types of solutions according to pH

- Neutral Solutions : Have $[H^+] = [OH^-]$ & $PH = 7$
- Acidic Solutions : Have $[H^+]$ more than $[OH^-]$ & $PH < 7$
- Basic Solutions : Have $[OH^-]$ more than $[H^+]$ & $PH > 7$

30. Types of solutions according to OP of body fluids

- Isotonic Solutions : Have OP. Similar to that of body fluids (0.9 g/dl NaCl)

- Hypertonic Solutions : Have OP. Higher than that of body fluids
- Hypotonic Solutions : Have OP. Lower than that of body fluids

31. 2 Importance of OP

Regulation of the volume of body fluids – urine formation

32. 2 Forces controlling formation of interstitial fluid or urine formation

Capillary blood pressure (filtration) - OP. of plasma Ptn (reabsorption)

33. Factors ↓ surface tension or hydrotropic or emulsifying agents or amphipathic compounds

Soap – phospholipids – bile salts

34. 1 property of solutions involved in chromatography

Elution

34. 1 property of solutions explains iodine test

Adsorption

35. 2 Methods for separation of colloids from crystalloids (purification of colloids)

Dialysis – Ultra-filtration

36. 3 Methods of fractionation of colloids (Ptn)

Ultracentrifugation – Precipitation – Electrophoresis – Chromatography

37. The ideal method for separation of Ptns that have different densities

Ultracentrifugation

38. The ideal method for separation of charged Ptns that have equal densities

Electrophoresis

39. Arrangement of plasma Ptns in electrophoresis

Albumin then α -globulin then β -globulin then γ -globulin and lastly fibrinogen

40. 2 Factors controlling migration of Ptns in electrophoresis

No. of charges – Molecular weight

41. 2 Trioses one ketose and the other is aldose

Dihydroxyacetone - Glyceraldehyde

42. 2 Ketopentoses

Ribulose - Xylulose

43. 4 Hexoses

Glucose - Galactose - Mannose - Fructose

44. Ketohexose & ketopentose

Fructose - Ribulose

45. 2 Optical isomers

Glyceraldehyde - Dihydroxyacetone

46. 2 forms of glucose in ring structure

α -D Glucopyranose - β -D Glucopyranose

47. 2 Sugar alcohols

Sorbitol – Ribitol

48. 2 sugar acids



Gluconic acid – Galactonic acid

4 . Importance of 2 pentoses

Ribose → RNA – D₂-deoxyribose → DNA

50. Importance of glucose

Present in blood & in many disaccharides & polysaccharides as :lactose , sucrose , maltose , starch & dextrin

51. Importance of fructose

Present in honey , semen , sucrose & inulin

52. Importance of galactose

Present in lactose & galactolipid

53. 2 Amino sugars

Glucosamine - Mannosamine

54. 1 Amino sugar and 1 deoxysugar

Glucosamine - D₂ deoxyribose

55. 2 Reducing disaccharides

Maltose - Lactose

56. 1 Non reducing and 1 reducing disaccharide

Sucrose (Non reducing) - Maltose

57. 4 Polysaccharides

Starch – Dextrin – Glycogen – cellulose

58. 1 Fructans

Inulin

59. 4 Glucans

Starch – Dextrin – Glycogen – cellulose

60. 4 GAGS

Sulfate free : Hyaluronic acid

Sulfate containing : Chondroitin sulfate - Dermatan Sulfate - Keratan sulfate - Heparin

61. 1 Sulfate free and 1 sulfate containing GAGS

Sulfate free : Hyaluronic acid

Sulfate containing : Chondroitin sulfate

62. Homopolysaccharides

Glucans : Starch – Dextrin – Glycogen – cellulose

Fructans : Inulin

63. Heteropolysaccharides

1. GAGs :

Sulfate free : Hyaluronic acid

Sulfate containing : Chondroitin sulfate - Dermatan Sulfate - Keratan sulfate – Heparin

2. Proteoglycans



64. 2 Disaccharides containing β linkages
Lactose – Cellobiose
65. 1 GAG act as anticoagulant & another 1 important for corneal transparency
Heparin – Keratan sulfate
66. 1 Sugar alcohol enter in the structure of vit B2 & another one for synthesis of TAG
Riboflavin - Glycerol
67. Product(s) of reduction of fructose & mild oxidation of glucose
Sorbitol & mannitol – gluconic acid
68. 1 Deoxy sugar for ABO blood group antigens & 1 N linked glycoside
L-fucose - Nucleotides
69. 1 levorotatory & 2 Dextrorotatory sugars
Fructose – glucose & sucrose
70. 3 GAGs containing L-iduronic acid
Dermatan sulfate – Heparin – Heparan sulfate
71. 1 GAG that is Highly anionic & doesn't contain uronic acid
Heparin – Keratan sulfate
72. 2 sugars 1 is present in semen & the other is present in blood
Fructose – glucose
73. 3 GAGs present in the eye
Hyaluronic acid – Keratan sulfate – Dermatan sulfate
74. 3 GAGs present in cartilage
KCH : Keratan sulfate – Chondroitin sulfate – Hyaluronic acid
75. 2 Aminosugar acids present in ABO blood group antigens
N-acetyl glucosamine – N-acetyl galactosamine
76. 2 Epimers
Mannose & glucose at C2 – Galactose & glucose at C4
77. 2 Sugars having 8 optical isomers 1 is ketose & the other is aldose
Fructose – Ribose
78. 2 Compounds containing ester bonds 1 is CHO & 1 is lipid
Glucose 6-P – TAG
79. Product of reduction of mannose
Mannitol
80. Product of reduction of glucose
Sorbitol
81. Product(s) of oxidation of glucose
Mild oxidation : Gluconic acid
Moderate oxidation : Glucuronic acid
Strong oxidation : Glucaric acid



82. 2 Difference between heparan sulfate & heparin

Heparan sulfate contains : More Glucuronic acid & its Glucosamine residues contain less sulfate

83. 2 Importance for hyaluronic acid

Cell migration & morphogenesis – Healing of wounds

84. Sites & importance of hyaluronidase

Cap of the sperm : Fertilization

Bacteria : Spread of infection

85. Anomeric carbon in glucose (aldoses)

C1

86. Anomeric carbon in fructose (ketoses)

C2

87. 1 Sulfate free & 1 uronic acid free GAGs

Hyaluronic acid – Keratan sulfate

88. 2 Amino sugar acids

Neuraminic acid – Sialic acid (NANA)

89. Types of simple lipids

TAG – Waxes

90. 2 short chain saturated fatty acids

Acetic acid - Butyric acid

91. 2 long chain saturated fatty acids

Palmitic acid , Stearic acid

92. 3 monoethenoid fatty acids

Palmitoleic acid - Oleic acid - Nervonic acid

93. 3 polyethenoid fatty acids (PUFA)

Linoleic acid , linoleic acid , Arachidonic acid

94. 2 essential fatty acids

Linoleic acid , Linoleic acid

95. 2 examples of waxes

Lanoline , Bee wax

96. 4 phospholipids

Phosphatidic acid – Lecithin – Cephalin - Lipositol

97. 3 glycolipids

Cerebroside – Sulfolipid - Ganglioside

98. Sphingosine containing lipids (sphingolipids) or ceramid containing compounds

Sphingomyelin - Cerebroside – Sulfolipid - Ganglioside

99. 2 sterols

Cholesterol – Ergosterol



- 100. 3 cholesterol derived substances (functions of cholesterol)**
Bile acids - Vit. D₃ - Steroid hormones
- 101. 4 bile acids**
Cholic acid - Chenodeoxycholic acid - Deoxycholic acid - Lithocholic acid
- 102. 2 male sex hormones (androgens)**
Testosterone - Dihydrotestosterone
- 103. 2 female sex hormones**
Estrogen - Progesterone
- 104. 3 estrogens**
Estradiol - Estriol - Estrone
- 105. 2 mineralocorticoids**
11-deoxycorticosterone - Aldosterone
- 106. 3 glucocorticoids**
Cortisol - Cortisone - Corticosterone
- 107. Functions of bile salts**
Digestion & absorption of fat
- 108. Choline containing compounds**
Sphingomyelin - Lecithin - Plasmalogen
- 109. 1 Primary & 1 secondary bile acids**
Primary : Cholic & chenodeoxycholic acid
Secondary : Lithocholic & deoxycholic acid
- 110. Parent FA of ω 3 family**
 α Linolenic acid
- 111. Parent FA of ω 6 family**
Linoleic acid
- 112. 2 Essential FA**
 α Linolenic acid - Linoleic acid
- 113. The most active Estrogen**
Estradiol
- 114. The main androgen secreted by testis**
Testosterone
- 115. The most active androgen**
Dihydrotestosterone
- 116. The most active glucocorticoids**
Cortisol
- 117. The most active mineralocorticoids**
Aldosterone
- 118. No. of carbon atoms in cholesterol – bile acids – testosterone – estrogen – progesterone**
27 – 24 – 19 – 18 – 21



119. 2 Bile salts

Na glycocholate – Na taurocholate

120. 1 Tetraethenoid & 1 pentaethenoid FA

Arachidonic – Timnodonic

121. 1 Tri ethenoid & 1 hexaethenoid FA

Linoleic – Cervonic

122. Non essential FA that becomes essential in absence of linoleic acid

Arachidonic acid

123. Nonessential FA that becomes essential in absence of α -linolenic acid

Timnodonic acid

124. 3 Carotenoids

α , β & γ Caroenes

125. 2 Enzymes involved in conversion of carotenoids to vit. A

Carotenase – Retinal reductase

126. 2 PUFA for synthesis of eicosanoids

Arachidonic acid – Timnodonic acid

127. Cyclic eicosanoids

PPT: Prostaglandins (PG) – Prostacyclins (PGI) – Thromboxanes (TX)

128. Non cyclic eicosanoids

LL: Leukotriens – Lipoxins

129. Eicosanoid act as vasoconstrictor & increase Platelets aggregation

TXA₂

130. Eicosanoid act as a vasodilator & decrease Platelets aggregation

PGI₂

131. Sulfur containing amino acids

Cysteine – Cystine - Methionone

132. Acidic amino acids

Aspartic acid – Glutamic acid

133. Basic amino acids

Lysine – Hydroxy Lysine - Arginine

134. Aromatic amino acids

Phenylalanine - Tyrosine

135. Heterocyclic amino acids

Proline – Hydroxy Proline – Tryptophan - Histidine

136. Hydroxy amino acid

Serine – Threonine – Homoserine – Tyrosine – Hydroxy Lysine

137. 3 aliphatic neutral amino acids

Glycine – Alanine – Valine – Leucine



- 138. 5 essential amino acids** *VITAL LYMPH*
 Valine – Isoleucine – Threonine – Arginine – Leucine
 Lysine – Tryptophan – Methionine – Phenylalanine - Histidine
- 139. Semi essential amino acids**
 Arginine - Histidine
- 140. 3 glucogenic amino acids**
 Glycine – Alanine – Serine – Threonine - ... etc.
- 141. Ketogenic amino acids**
 Lysine - Leucine
- 142. Mixed ketogenic and glucogenic amino acids**
 Proline – Hydroxy Proline – Tryptophan - Isoleucine
- 143. 2 forms of secondary structure of Ptn.**
 α helix – β Pleated sheets
- 144. Forces that maintain the tertiary structure of Ptn.**
 Hydrogen bond - Hydrophobic bond – Van der Waals - Ionic bond - Disulfide bond
- 145. Forces that maintain the quaternary structure of Ptn.**
 Hydrogen bond - Hydrophobic bond – Vander Waals - Ionic bond - Disulfide bond
- 146. Globular Ptns**
 Albumin – Globulin - Insulin
- 147. Fibrous ptns**
 Collagen – Elastin - Keratin
- 148. Simple ptns**
 Albumin – Globulin – Scleroprotein
- 149. Phosphoproteins**
 Caseinogen - Vitellin
- 150. 3 glycoproteins**
MECH TPACI: Mucin – Enzymes as alk. Phosphatase – Collagen – Hormones as FSH
- 151. Non heme iron (NHI) containing Ptns**
 Ferritin – Transferrin - Haemosiderin
- 152. Copper containing Ptns**
 Lysyl oxidase – Cytochrome oxidase – Superoxide dismutase
- 153. Magnesium containing Ptns**
 Kinase – Phosphatase - Phosphorylase - Enolase
- 154. Manganase containing Ptns**
 Carboxylase – Arginase – Choline esterase – Mitochondrial superoxide dismutase
- 155. Zinc containing Ptns**
 Insulin – Carbonic Anhydrase – Carboxy peptidase – Cytosolic superoxide dismutase

- 156. Hemoproteins**
Hemoglobin – Myoglobin – Cytochromes - Catalase
- 157. 4 properties of Ptn**
Colloidal properties- Amphoteric properties- Denaturation- Separation by different methods
- 158. Essential sulfur containing aa**
Methionine
- 159. Essential hydroxyl aa**
Threonine
- 160. Essential aromatic aa**
Phenylalanine – Tryptophan
- 161. Essential basic aa**
Lysine
- 162. Essential heterocyclic aa**
Tryptophan
- 163. Essential aliphatic aa**
Valine – Leucine – Isoleucine
- 164. Imino acids**
Proline – hydroxyproline
- 165. Hydroxy aa doesn't enter the structure of Ptn**
Homoserine
- 166. Sulfur containing aa doesn't enter the structure of Ptn**
Homocystiene
- 167. Diamino dicarboxylic aa**
Cystine
- 168. 2 Methylated derivatives of aa**
Monomethyl glycine (sarcosine) - Dimethyl glycine & Trimethyl glycine (Glycine betaine)
- 169. Result of oxidative deamination of aa**
 α keto acids
- 170. Result of decarboxylation of aa**
Primary amines
- 171. Result of decarboxylation of tyrosine – Tryptophan – Histidine**
Tyramine – Tryptamine – Histamine
- 172. 3 Chromo non metallo proteins**
Melanin – Rhodopsin – Flavo proteins (succinate DH)
- 173. 2 Forms of secondary structure of Ptn**
 α -helix – β -pleated sheets
- 174. 2 Optically inactive compounds 1 is aa & the 2nd is sugar**
Glycine – Dihydroxyacetone



175. 1 essential aa & 1 essential FA

Threonine – Linoleic acid

176. Ptn containing Rt handed helix & another 1 containing left handed helix

Keratin – Collagen

177. Factors interfering e` formation of Rt. Handed helix

1. Proline: Can't form hydrogen bond
2. Many successive aa with bulky R as tryptophan
3. Many successive acidic or basic aa as glutamate, aspartate, Arginine or lysine

178. 2 Different Ptns having quaternary structure

Hemoglobin – Collagen

179. Bond(s) stabilizing primary structure

Peptide – Disulfide (if present)

180. Bond(s) stabilizing secondary structure

Hydrogen bond

181. 2 Acidic aa & 2 acidic Ptns

Aspartic , glutamic acids – Gliadins , glutelins

182. 2 Basic aa & 2 basic Ptns

Arginine , histidine – Protamines , histones

183. Heat coagulable Ptns

Albumin – Globulin - Gliadins – Gluelins

184. 2 Structural proteins

Collagen - Elastin

185. 2 Specialized proteins

Fibronectin - Fibrillin

186. Structural unit of collagen

Tropocollagen

187. Structural unit of elastin

Tropoelastin

188. Commonest amino acid in collagen

Glycine then proline & hydroxy proline

189. Sites of collagen

Skin , bone , cartilage , tendons , ligaments , BV & cornea

190. 2 Differences between gelatin & collagen

Gelatin is easy to be digested & soluble in warm water unlike collagen

191. How to convert procollagen α chain to procollagen α chain

1. Removal of the signal Peptide by signal peptidase
2. Hydroxylation of prolyl & lysyl residues by prolyl & lysyl hydroxylase (requires vit. C)
3. Glycosylation of hydroxylysyl residues



192. Commonest non collagenous Ptn in cartilage

Aggrecan

193. Commonest non collagenous Ptn in bone

Osteocalcin

194. 3 GAGs present in aggrecan

KCH: Keratan sulfate – Chondroitin sulfate – Hyaluronic acid

195. 2 Vitamins related to osteocalcin

Vit. D : Induces its synthesis

Vit. K : Carboxylation of glutamate residue to γ carboxy glutamate that can bind Ca

196. Type of Hb used to follow up diabetic patients

HbA1c (glycosylated Hb)

197. 2 Normal & 2 abnormal Hb

Hb A , Hb F – Hb M , Hb C

198. The defect in HbS disease

Replacement of glutamate (the 6th aa in β chain) by valine

199. The defect in HbC disease

Replacement of glutamate (the 6th aa in β chain) by lysine

200. The defect in HbM disease

Replacement of proximal or distal histidine by tyrosine

201. 2 Toxins can bind to the same oxygen binding sites

CO – Cyanide

230. 2 Mechanisms for enzyme action

1. Lowering the energy of activation

2. Induced fit theory

231. Types of enzyme catalyzed reactions

Exergonic (exothermic) – Endergonic (endothermic) – Isothermic

231. 2 different types of isoenzymes

Lactate dehydrogenase (LDH) $\rightarrow$ 5 isoenzymes

Creatine kinase (CK) $\rightarrow$ 3 isoenzymes

232. 2 isoenzymes can be used in diagnosis of myocardial infarction

LDH₁ – CK₂ (CK_{MB})

233. Enzymes increased in cases of pancreatitis

Amylase - Lipase

234. Enzymes increased in cases of hepatitis

ALT - AST

235. 2 Significances of Km

1. Index for affinity

2. Isoenzymes have different Km

36. 2 zymogens (proenzymes)

Pepsinogen – Trypsinogen

37. 2 Competitive inhibitors

1. Allopurinol : for xanthine oxidase (so it is used for treatment of gout)
2. Warfarin & dicumarol : for vit. K reductase (so they are used as anticoagulants)

38. 2 Irreversible non specific enzyme inhibitors

1. Factors causing denaturation of the enzyme : strong acid or base
2. SH group inhibitors : as oxidizing agents , alkylating agents or salts of heavy metal
3. Inhibition by removal of the catalytic ion : EDTA binds Ca & inhibits coagulation

239. 3 Methods for regulation of the enzyme activity

1. Regulation of enzyme quantity : by controlling synthesis & degradation
2. Regulation of enzyme activity : by activators & inhibitors
3. Compartmentalization

240. 2 Irreversible enzyme inhibitors act by removal of the catalytic ion

1. EDTA : binds Ca^{+2} & inhibits blood clotting
2. Fluoride : binds $\text{Ca}^{+2} \rightarrow$ inhibits blood clotting & binds $\text{Mg}^{+2} \rightarrow$ inhibits enolase & glycolysis

241. Types of enzyme specificity

1. Absolute specificity : Lactase , Sucrase Etc.
2. Group specificity : trypsin hydrolyzes peptide bond the COOH of w` for basic aa.
3. Stereo-optical specificity : acts only on L or D form compounds

242. Enzymes that can act on both L & D form compounds

Racemases

243. Effect of allosteric activators on Km & Vmax

Km : Decreased - Vmax : Increased

244. Effect of competitive inhibitors on Km & Vmax

Km : Increased - Vmax : No effect

245. Effect of non competitive inhibitors on Km & Vmax

Km : No effect - Vmax : decreased

246. Effect of allosteric inhibitors on Km & Vmax

Km : increased - Vmax : decreased

247. SH group inhibitors

Oxidizing agents – Alkylating agents – Salts of heavy metals

248. OH group inhibitors

Aspirin – DFP (nerve gas)

249. 2 Anti enzymes

Anti thrombin – Anti proteinases (anti trypsin)

250. Major purines

Adenine – Guanine



251. Oxypurines (purines not present in DNA)

Hypoxanthine – Xanthine – Uric acid

252. Minor purines

N⁶ methyl adenine – N⁶,N⁶ dimethyl adenine – 7 methyl guanine

253. Methyl purines of dietary origin

- a. Caffiene in coffee
- b. Theophylline in tea
- c. Theobromine in cocoa

254. Major pyrimidines

Thymine – Uracil – Cytosine

255. Minor pyrimidines

Dihydrouracil – 5 methyl cytosine – 5 hydroxymethyl cytosine

256. Nitrogenous bases present in DNA

Adenine – Guanine – Thymine – Cytosine

257. Nitrogenous bases present in RNA

Adenine – Guanine – Uracil – Cytosine

258. 4 Purine nucleosides

Adenosine – Guanosine – Inosine - Xanthosine

259. 3 Pyrimidine nucleosides

Thymidine – Uridine – Cytidine

260. 2 Purine nucleotides

ATP – GTP

261. 2 Pyrimidine nucleotides

TTP – UTP – CTP

262. 2 Cyclic nucleotides of medical importance

cAMP – cGMP

263. 2 Free nucleotides having a role in energy transfer

ATP – ADP

264. 1 Free nucleotide acts as a hormone 2nd messenger & 1 acts as sulfate donor

cAMP – PAPS

265. 1 Free nucleoside & 1 Free nucleotide acts as a hydrogen carrier

SAM – FMN or (FAD , NAD or NADP)

266. Function of SAM

It is a free nucleoside w^h acts as methyl donor in the body :

Noradrenaline $\xrightarrow{\hspace{2cm}}$ Adrenaline

Ethanolamine $\xrightarrow{\hspace{2cm}}$ Choline

**267. 1 Enzyme inhibited & another one activated by phosphorylation
(covalent modification)**

Glycogen synthase – Glycogen phosphorylase



268. Vitamin containing free nucleotides

Flavin (vit B₂) : FMN - FAD

Nicotinamide (vit B₃) : NAD – NADP

Pantothenic acid (vit B₅) : CoASH

269. 2 Enzymes can be activated using G protein as a signal trasducer

Adenylate cyclase – Phospholipase C

270. Specific type of G protein its mutation may lead to cancer

Ras protein

271. Enzyme can break down cAMP & cGMP

Phosphodiesterase

272. Functions of UDP glucuronate

Active form of glucuronic acid , can be used for :

a. synthesis of GAGs

b. Conjugation of steroids , bilirubin & drugs

273. Adenine nucleotides of biological importance

1. AMP – ADP – ATP

2. cAMP

3. SAM

4. PAPS

5. Coenzymes containing Adenine (vitamin derivatives) : FMN – FAD – NAD – NADP – CoASH

274. Guanine containing free nucleotides of biological importance

1. GMP – GDP – GTP

2. cGMP

275. Cytosine free nucleotides of biological importance

1. CMP – CDP – CTP

2. CDP choline – CDP ethanolamine – CDP-DAG

276. Uracil free nucleotides of biological importance

1. UMP – UDP – UTP

2. UDP-glucose – UDP-galactose – UDP-glucuronic acid

277. The end product of purine catabolism

Uric acid

278. Function of cGMP or cAMP

Acts as a hormone 2nd messenger

279. Function of G protein

Acts as a signal transducer

280. Simple (structural) unit of the chromatin or chromatid

Nucleosome

281. Base Pairing rule in DNA

Adenine (A) pairs e` Thymine (T) by 2 hydrogen bonds



Guanine (G) pairs e` Cytosine (C) by 3 hydrogen bonds

282. Types of RNA

mRNA – tRNA – rRNA

283. Types of supercoiling in linear DNA

Toroidal – Interwound coil

284. Types of supercoiling in circular DNA

Rt handed supercoil – Lt handed supercoil

285. Levels of packing of the DNA

a. 10 nm fibril : packing ratio 10

b. 30 nm fibre : packing ratio 50

c. Chromatid : pakig ratio 8000

286. Function of mitochondrial DNA

Synthesis of 22 tRNA , 13 Ptn & 2 rRNA all are involved in oxidative phosphorylation

287. Factors needed for separation of the 2 DNA strands (initiation) in replication

dna A – dna B (Helicase) – dna C – SSBP – ATP

288. Main enzyme for replication in prokaryotes & has a proof resding activity

DNA polymerase III

289. DNA dependent RNA polymerase that forms RNA primer in replication in prokaryotes

Primase

290. Enzyme removes the RNA primers & fills the gaps in replication of prokaryotic DNA

DNA polymerase I

291. Enzyme joins the DNA fragments together

Ligase

292. Enzyme solves the problem of DNA supercoiling & doesn't need ATP

Topoisomerase I

293. Enzyme solves the problem of DNA supercoiling & t needs ATP

Topoisomerase II (DNA gyrase)

294. Main enzyme of replication in eukaryotes & has proof reading activity

DNA polymerase δ for the lagging strand & DNA polymerase ϵ for the leading strand

295. Enzymes responsible for DNA repair

Prokaryotes : DNA polymerase II

Eukaryotes : DNA polymerase β & ϵ

296. Enzyme removes RNA primers during replication in eukaryotes

Rnase H

297. Enzyme with a reverse transcriptase activity solves the problem of tolemere shortening in replication

Telomerase

298. RNA primer connected to short fragment of DNA

Okazaki fragment



299. 2 Differences between pro & eukaryotic replication

Main enzyme : in pro. DNA polymerase III , in eu. DNA polymerase δ

RNA primer : In pro 5 RN , in eu. 10 RN

300. Types of DNA polymerases in prokaryotes

DNA polymerase I : removes RNA primers & fills the gaps

DNA polymerase II : DNA repair

DNA polymerase III : elongates leading & lagging strand & has proofreading activity

301. Types of DNA polymerases in eukaryotes

DNA polymerase α : forms a complex e` primase & forms RNA primer & a stretch of DNA

DNA polymerase β : DNA repair enzymes

DNA polymerase γ : replicates mitochondrial DNA

DNA polymerase δ : elongates lagging strand & has proofreading activity

DNA polymerase ϵ : elongates the leading strand & DNA repair

302. Functions of topoisomerases

Topoisomerase I : solves the problem of supercoiling e` out ATP

Topoisomerase II : solves the problem of 2 interlocked circular DNA in bacteria

303. 2 Proteins involved in replication

dna A – Helicase - SSBP

304. Enzymes concerned with DNA repair

Prokaryotes : DNAP II – euokaryotes : DNAP β & ϵ

305. Structure of prokaryotic RNA polymerase

Core enzyme : 2 identical α + 2 similar β subunits ($\beta \beta'$)

Holoenzyme complex : core enzyme + σ factor w` recognizes the promoter

306. Post transcriptional processing of mRNA

1. Capping : at the 5` end by 7 methyl GTP

2. Polyadenylation : addition of poly A tail at the 3` end

3. Splicing : cutting of the introns & joining of the neighboring exons

4. mRNA editing : changing the coding information of mRNA

307. Ways of termination of transcription in prokaryotes

a. Rho (ρ) dependent termination

b. Rho independent termination (intrinsic termination)

308. Importance of snRNA

Enter the structure of the enzyme spliceosome w` is responsible for splicing

309. Ways of DNA modification (gene alteration)

1. Amount of DNA :

a. Gene amplification

b. Gene diminution

2. Gene rearrangement or recombination

310. ways of access to DNA (chromatin remodelling)

- a. Methylation of cytosine
- b. Acetylation of histones

311. Basal expression elements

- a. TATA box
- b. CAAT box
- c. GC box

312. Cis acting elements (Regulated expression elements)

- a. Enhancers
- b. Silencers
- c. Hormone response elements
- d. Tissue specificity elements

313. Requirements for protein synthesis (translation)

- 1. Ribosomes
- 2. Amino acids
- 3. mRNA
- 4. tRNA
- 5. Aminoacyl tRNA synthetase
- 6. Source of energy (ATP & GTP)
- 7. Protein factors (initiation, elongating & releasing factors)

314. Post translational processing of protein

- a. Trimming : removal of a part of the polypeptide chain
- b. Covalent alteration :
 - 1. Phosphorylation
 - 2. Glycosylation
 - 3. Hydroxylation
 - 4. Carboxylation
 - 5. Biotinylation
 - 6. Methylation

315. Causes of gene mutation

- 1. Error in DNA replication
- 2. Error in DNA recombination
- 3. Exposure to chemicals
- 4. Exposure to radiation
- 5. Exposure to oxidizing agents
- 6. Spontaneous : Deamination of cytosine
Depurination
Tautomerism

316. Types of mutations

- 1. Base substitution mutation (transition or transversion)
- 2. Insertion mutation
- 3. Deletion mutation

317. Effects (types) of substitution mutation

- 1. Missense
- 2. Nonsense
- 3. Silent mutation

318. Phases of cell cycle

- 1. G_1 : (6 - 12 hours) RNA & Ptn synthesis "cell prepare itself for replication"
- 2. S : (6 - 8 hours) Replication
- 3. G_2 : (3 - 4 hours) RNA & Ptn synthesis "cell prepare itself for mitosis"
- 4. M : (1 hour) Cell division

319. Protein factors that regulate the cell cycle

- 1. Cyclin Dependent kinases "CDK" (1 to 6)

1. Cyclins (A to E) binds to CDK & forms MPF
3. Cyclin Kinase Inhibitors (CKI) : P₁₆ & P₂₁ , inhibits CDK-cyclin complex

1. Cell cycle checkpoints

1. First checkpoint (G1 check point): Check for cell size , nutrient , growth factors & DNA damage
2. Second checkpoint (G2 checkpoint) : Check for cell size & DNA damage
3. Third checkpoint (Spindle assembly check point): Check that mitotic spindle is attached to all kinetochores

!1. 1 apoptotic & 1 anti apoptotic protein

Bax protein – Bcl-2

22. 2 Tumor suppressor genes

- a. Retinoblastoma tumor suppressor gene
- b. P53 tumor suppressor gene

23. Importance of apoptosis

ECMAAT

1. Emryonic development
2. Cancer
3. Menstrual cycle
4. Aging
5. Autoimmune diseases
6. Thymus atrophy

332. Applications (uses) of PCR

2S 2D F

1. Synthesis of DNA for cloning
2. Synthesis of proteins : insulin – GH – Vaccines
3. Diagnosis of genetic diseases
4. Detection of bacterial & viral infection i.e. HIV & hepatitis B
5. Forensic medicine : amplification of DNA from hair or sperm

333. 2 advantages of PCR over cloning

- a. Simple
- b. Sensitive
- c. Faster

334. Uses of Hybridization (FISH) technique

1. Gene mapping
2. Diagnosis of genetic diseases
3. Diagnosis of viral or bacterial infection
4. Diagnosis of cancer

335. Fluorescence dye used to visualize DNA

Ethidium Bromide

336. 3 Diseases due to defects in DNA repair

Xeroderma pigmentosum – Ataxia telangectasia – Werner's syndrome

337. Types of DNA repair

Mismatch repair – Base excision repair – Nucleotide excision repair



338. Optimum pH for most enzymes

Between 5 & 9

341. Mesocompound

Mucic acid (galactaric acid)

345. Importance of enzyme specificity

Digestive enzymes are of low specificity allowing few No. of enzymes to digest all food stuffs

Metabolic enzymes are of high specificity to be well regulated

346. Example of allosteric activator

AMP activates PFK1

347. 2nd messenger for adenylate cyclase

cAMP

348. 2nd messenger for phospholipase C

IP₃ & DAG

349. Structural forms of the double helix (forms of DNA)

- B form (B-DNA) : described by Watson & crick

- A form : dehydrated B form

- Z form (Z-DNA) : at regions of alternating purines & pyrimidines i.e. poly GC

350. Importance of untranslated regions in mRNA (UTR) → 3' UTR & 5' UTR

mRNA stability – mRNA localization – efficiency of translation

4. What is the chemical nature of :

1. Ribose

Aldopentose – Monosaccharide – Carbohydrates

2. Ribulose or (Xylulose)

Ketopentose – Monosaccharide – Carbohydrates

3. Glucose or(Galactose) or(Mannose)

Aldohexose – Monosaccharide – Carbohydrates

4. Fructose

Ketohexose – Monosaccharide – Carbohydrates

5. Maltose or (isomaltose) or (lactose) or (cellobiose)

Reducing disaccharide – Disaccharide – Oligosaccharide - Carbohydrate

6. Sucrose

Non reducing disaccharide – Disaccharide – Oligosaccharide - Carbohydrate

9. D₂- Deoxyribose

Deoxy sugar – Monosaccharide derivative – Monosaccharide – carbohydrate

10. Ribitol or (Sorbitol) or (Mannitol) or (Inositol)

Sugar alcohol – Monosaccharide derivative – Monosaccharide – carbohydrate



- 11. Glucuronic acid or (Gluconic acid)**
Sugar acids – Monosaccharide derivative – Monosaccharide – carbohydrate
- 12. Starch or(dextrin) or (glycogen) or (cellulose)**
Glucosans – Homopolysaccharide – Polysaccharide – Carbohydrate
- 13. Inulin**
Fructans – Homopolysaccharide – Polysaccharide – Carbohydrate
- 14. Hyaluronic acid**
Sulfate free GAG – GAGs – Heteropolysaccharide – Polysaccharide - Carbohydrate
- 15. Heparin or (Chondroitin sulphate) or (Dermatan sulphate) or (keratan sulphate)**
Sulfate containing GAG – GAGs – Heteropolysaccharide – Polysaccharide – Carbohydrate
- 16. Neuraminic acid**
Amino sugar acid – Monosaccharide derivatives – Monosaccharide – Carbohydrates
- 17. Triacylglycerol (TAG)**
Simple lipid - Lipid
- 18. Waxes**
Simple lipid - Lipid
- 19. Phosphatidic acid – Lecithin – Cephalin – Lipositol – Plasmalogen –Cardiolipin – Sphingomyelin**
Phospholipid – Compound lipid – lipid
- 20. Cerebroside – Sulfolipid – Ganglioside - Globosides**
Glycolipid – Compound lipid - lipid
- 21. Glycerol – Sphingosine**
Alcohol – Derived lipid – lipid
- 22. Cholesterol**
Zoosterol – Sterol – Steroid – Derived lipid – lipid
- 23. Cholic acid or Chenodeoxycholic or Deoxycholic or Lithocholic acid**
Bile acid – Steroid – Derived lipid - lipid
- 24. Cortisol – Cortisone – Corticosterone**
Glucocorticoids – Corticoids – Steroid hormone – Steroid – Derived lipid – Lipid
- 25. Aldosterone**
Mineralocorticoids – Corticoids – Steroid hormone – Steroid – Derived lipid – Lipid
- 26. Testosterone or Dihydrotestosterone**
Male sex hormone – Sex hormone – Steroid hormone – Steroid – Derived lipid – lipid
- 27. Estradiol or Estriol or Estrone or Progesterone**
Female sex hormone – Sex hormone – Steroid hormone – Steroid – Derived lipid – lipid
- 28. Albumin or Globulin**
Simple protein – Protein

29. Collagen – Elastin – Keratin

Scleroprotein - Simple protein - Protein

30. Casinogen – Vitellin

Phosphoprotein – Compound protein - Protein

31. Mucin

Glycoprotein – Compound protein - Protein

32. Hemoglobin – Myoglobin – Cytochrome – Catalase

Hemoproteins – Metalloproteins – Compound protein - Protein

33. Ferritin – Transferrin – Haemosiderin

Non heme iron containing Ptn Fe – Metalloprotein – Compound protein - Protein

34. Lysyl oxidase – Superoxide dismutase – Cytochrome oxidase

Cu containing protein – Metalloprotein – Compound protein – Protein

5. Compare Between :**1. Different types of solutions**

	True (Crystalloidal)	Colloidal	Suspensions
Size of solute particles	< 1 nm (Homogenous)	1 – 200 nm	> 200 nm (Heterogenous)
Visibility of particles	- Naked eye X - Microscope X	- Naked eye X - Microscope ✓	- Naked eye ✓ - Microscope ✓
Pass through	- Filter Paper ✓ - Cellophane Paper ✓	- Filter Paper ✓ - Cellophane Paper X	- Filter Paper X - Cellophane Paper X
Precipitation	Not	By centrifugation	Spontaneously
Examples	- NaCl , glucose or urea in water	- Starch in water or - Protein in water	- Charcoal or sand in water & - RBCs in plasma

2. Emulsoids & Suspensoids

Emulsoids	Suspensoids
Highly Charged	Poorly Charged
Surrounded by water film (Hydrophilic)	Not surrounded by water film (Hydrophobic)
Difficult to be Precipitated i.e. needs Concentrated solution of NaCl	Easy to be precipitated i.e. needs diluted solution of NaCl
Can be redissolved (precipitation is reversible)	Once precipitated never redissolved (precipitation is irreversible)
Examples : Starch & Ptn in water	Examples : - Colloidal gold in water - Ferric Hydroxide in water

• Molar & Normal solutions

Molar Solutions	Normal Solutions
- Contain the molecular weight in grams dissolved in 1 litre of water (1 gm mole / Litre or M)	- Contain the equivalent weight in grams dissolved in 1 litre of water (equivalent wt in gm / Litre or N) • Equivalent weight : Molecular weight In grams divided by the valence • Valence is No of H^+ for acids or OH^- for bases supplied by 1 molecule
- Both are the <u>Same</u> in case of HCl or NaOH (contain 1 H^+ or 1 OH^-) - Molar Solution is <u>Twice</u> the normal solution of H_2SO_4 (contain 2 H^+) - Molar Solution is <u>Triple</u> the normal solution of H_3PO_4 (contain 3 H^+)	

4. Amylose & amylopectin

Amylose	Amylopectin
15 %	85 %
Inner part of starch granules	Outer part of starch granules
Linear (in the form of a helix)	Branched
Formed of 300 Glucose residues	24-30 Glucose residues in each branch
Molecular weight : lower	Higher
United by α 1-4 glucosidic linkage	α 1-4 glucosidic linkage & α 1-6 Glucosidic linkage at branching points
Deep Blue color e` iodine	Red to Violet color e` iodine
Hydrolyzed by α - amylase to Maltose then to D-glucose	Hydrolyzed by α - amylase to Maltose & Isomaltose then to D-glucose

5. Amylopectin & glycogen

	Amylopectin	Glycogen
Building units	D-Glucopyranose α	
Number of units in each branch	24 – 30 Less Branched	8 – 12 More Branched
Molecular Weight	Lower	Higher
Color e` Iodine	Red to Violet	Red
Action of amylase	Maltose + Isomaltose	
Sources	In Plants i.e. cereals , legumes & tubers	In animals Liver & Muscle

6. Albumin & Globulin

Albumin	Globulin
Heat coagulable	
High biological value	
Give Positive result e` all color reactions	
Lower molecular weight	Higher molecular weight
Precipitated by full saturation ammonium sulfate	Precipitated by Half saturation ammonium sulfate
As: Ovalbumin Lactalbumin Plasma albumin	Ovoglobulin Lactglobulin Plasma globulin

7. Glycoprotein & proteoglycans

	Proteoglycan	Glycoproteins
Ptn content	5 %	More than 5 %
Type of CHO	GAGs	Oligosaccharide chain e` No : • Uronic acid • Repeating disaccharides
Examples	Proteoglycans in CT , cornea & sclera	Igs , collagen , mucinetc.

8. Salting in & Salting out

	Salting in	Salting out
Def.	The increase in solubility (as observed for some proteins) by dilute salt solution as compared to pure water	The precipitation of a protein from its solution by saturation or partial saturation with such neutral salts as sodium chloride
Examples	globulin is soluble only in diluted solutions	- Full saturation Ammonium Sulfate precipitates Albumin - Half saturation Ammonium Sulfate precipitates Globulin

Hemoglobin & Myoglobin

	Myoglobin	Hemoglobin
Site	Muscle	RBCs
Function	Storage of O ₂	1. Carry O ₂ from lung to tissues & CO ₂ from tissues to lung 2. Buffer system
Structure	1 heme & 1 polypeptide chain	4 heme & 4 polypeptide chains
No. of O ₂ / molecule	Carries 1 O ₂ molecule	carry 4 O ₂ molecules
Affinity to O ₂	Higher affinity	Lower affinity
Types	1 type	Many types : HbA, A ₂ , F

10. Adult hemoglobin & fetal hemoglobin

Adult Hb	Fetal Hb
Lower affinity for oxygen	Higher affinity for oxygen
Higher affinity to 2,3 BPG	Lower affinity to 2,3 BPG
Faster in electrophoresis	Slower in electrophoresis

11. Competitive & non competitive inhibitors

Competitive Inhibitors	Non Competitive Inhibitors
Both are Types of reversible inhibition	
The inhibitor is similar (Structural Analogue) to the Substrate	There is No Similarity between the inhibitor and the substrare
The inhibitor Competes e' the substrate for the active site of the enzyme	there is No Competition between the inhibitor and the substrate for the Enzyme
K _m : Increased V _{max} : NO effect	K _m : NO effect V _{max} : Decrease
Examples: 1- Allopurinol 2- Warfarin & dicumarol أشرح من النظري notes	

12. DNA & RNA

	DNA	RNA
1- <u>S</u> ite	Nucleus	Cytoplasm
2- <u>S</u> ugar	Deoxy-ribose	Ribose
3- <u>S</u> trands	Two strands	One strand
4- <u>S</u> hape	Double helix	Variable
5- <u>B</u> ases:- a) Purines b) Pyrimidines	Adenine & Guanine Cytosine & <i>Thymine</i>	Adenine & Guanine Cytosine & <i>Uracil</i>
6- <u>T</u> ypes	One type	3types mRNA , tRNA , rRNA
7- <u>F</u> unction	Carries the genetic characters	Protein synthesis

13. Prokaryotic & eukaryotic replication

	Prokaryotic replication	Eukaryotic replication
Origin of replication	Only one	Multiple
Replication fork	Only two	Multiple
Replication is :	Rapid	Slow
RNA primer	5 RN	10 RN
Okazaki fragments	Longer	Shorter
Main enzyme	DNA polymerase III	DNA polymerase δ
Primer synthesis	Primase	DNA polymerase α -primase complex
Removal of primers	DNA polymerase I	Rnase H
Filling of gaps	DNA polymerase I	DNA polymerase δ
Enzymes of repair	DNA polymerase II	DNA polymerase β & ϵ

14. Leading strand & lagging strand

Leading strand	Lagging strand
Synthesized towards the replication fork	Synthesized away from the replication fork
1 RNA primer	Multiple RNA primers
Synthesized continuously	Synthesized discontinuously

15. Prokaryotic & eukaryotic RNA polymerases

Prokaryotic RNAP	Eukaryotic RNAP
Single RNA polymerase ($\alpha 2\beta\beta'$)	RNAP 1: rRNA, except 5S rRNA RNAP 2: mRNA and some snRNA RNAP 3: tRNA, 5S rRNA
Requires sigma (σ) to initiate at a promoter	No sigma, but transcription factors (TFIID) bind before RNA polymerase
Sometimes requires rho (ρ) to terminate	No rho required
Inhibited by Rifampicin	RNAP 2 inhibited by α -Amanitin (mushrooms)

Differences & Similarities between replication & transcription

	Replication	Transcription
Def.	Synthesis of DNA	Synthesis of RNA
Site	Both in the nucleus	
Time	Before cell division (S phase)	For protein synthesis
Template	Both require DNA template	
Enzymes	DNA Polymerases	RNA Polymerases
Substrates	Deoxyribonucleoside triphosphate	Ribonucleoside tri phosphate
Direction	Reading : 3' to 5' - Synthesis 5' to 3'	

17. Eukaryotic & prokaryotic translation

	Translation in eukaryotes	Translation in prokaryotes
Ribosome	80 s ribosome (60s & 40s)	70s ribosome (50s & 30s)
1 st amino acid	Methionine	N-formyl methionine
Process	Discontinuous as transcription occur in nucleus & translation in cytosol	Both transcription and translation in cytosol
Speed	Slow: 1 aa / second	Rapid: 20 aa / second
mRNA	Monocistronic	Polycistronic

6. Explain Why

1. Vander Waals force is the weakest non covalent force

As it results from transient attraction between 2 atoms when they are close to each other

2. Water is described by being dipole

- As it is formed from 2 atoms of hydrogen bound to 1 atom of oxygen by covalent bonds
- There is unequal sharing of electrons
- Each hydrogen carries partial positive charge
- Oxygen carries 2 partial negative charge
- So water is dipolar & can form maximally 4 hydrogen bonds (in ice)

3. Water can form hydrogen bonds

As above

4. Thermal properties of water

Due to its ability to form hydrogen bonds so according to the No. of hydrogen bonds it is present in 3 forms : Liquid (2 to 3) – Ice (4) – vapour (no hydrogen bonds)

5. Water is known as a universal solvent

Due to the dipolar structure of water many compounds can be dissolved in water

- Ionic molecules as NaCl dissolve by → Solvation Spheres
- Polar molecules dissolve by formation of → Hydrogen bonds
- Non polar molecules → Not soluble in water
- Amphipathic compounds → form micelles

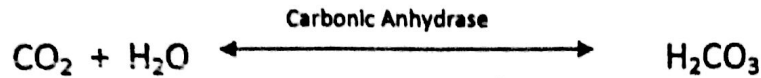


6. Metabolic water is of significant importance

Allow some animals in very dry habitats to survive for extended periods without drinking water as (gerbils, rats, camels & kangaroo)

7. Bicarbonate buffer system is the most important buffer in the body

1. Present in higher concentrations than other buffers
2. Easily formed at the tissues from CO_2 by Carbonic Anhydrase enzyme

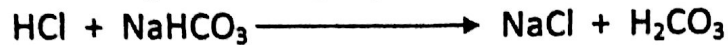


3. Easily corrected by respiration; CO_2 is excreted & expired air at Lungs

8. Bicarbonate buffer system is strongly related to lungs

• Addition of a strong acid i.e HCL :

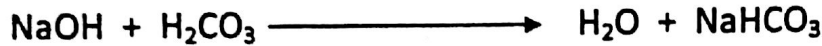
- Reacts & bicarbonate forming NaCl & H_2CO_3 w` is a weak acid



- H_2CO_3 is converted to H_2O & CO_2 w` stimulates respiration
- So the metabolic acids like HCL are converted to respiratory (volatile) acids

• Addition of a strong base i.e NaOH

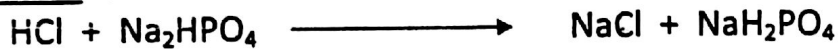
- Reacts & carbonic acid forming water & Na bicarbonate w` is a weak basic salt



- NaHCO_3 is formed & the level of H_2CO_3 decreases (as it buffers NaOH) so ;
- More CO_2 binds & H_2O to replace H_2CO_3 & inhibition of respiration

9. Phosphate buffer system is related to kidneys

• Addition of strong acid : ○



- So the strong acid (HCl) is converted to weak acid (NaH_2PO_4) w` is excreted by the kidneys (urine becomes more acidic)

• Addition of strong base :



- So the strong base (NaOH) is converted to weak base (Na_2HPO_4) w` is excreted by the kidneys (urine becomes more alkaline)

10. Hypokalemia leads to metabolic alkalosis

As Na is reabsorbed normally by Na/K pump in exchange of K or H^+ in cases of hypokalemia Na is reabsorbed in exchange of hydrogen leading to metabolic alkalosis

11. Hypoproteinemia leads to edema

↓ Plasma Ptns → ↓ OP. of Plasma Ptns → ↓ Reabsorption at the venular end of the capillaries → accumulation of fluids → Oedema

12. Diuretics increases urine volume

As they ↓ renal tubular reabsorption of Na

13. In DM there is polyuria

As in DM there is excretion of glucose in urine w` absorbs water by osmosis leading to polyuria



4. Colloidal OP is more important than crystalloidal pressure

As it controls passage of fluids across membranes as the concentration of proteins is higher in plasma than in the interstitial fluid (being non diffusible) , while the concentration of crystalloids is equal in the 2 fluids (being diffusible)

15. In electrophoresis the medium is alkaline

As Ptns are amphoteric so in alkaline medium they carry -ve charges & migrate towards the anode

16. Glucose is aldose while fructose is ketose

As glucose contains aldehyde group and fructose contains ketol group

17. Ribose is pentose while glucose is hexose and both are monosaccharides

Ribose is pentose as it contains 5 carbon atoms and glucose is hexose as it contains 6 carbon atoms both are monosaccharides as both are formed of 1 sugar units

18. Dihydroxyacetone is optically inactive

As it contains no asymmetric carbon atoms

19. Glyceraldehyde is optically active while dihydroxyacetone is not

As Glyceraldehyde contains 1 asymmetric carbon while dihydroxyacetone contains no asymmetric carbons

20. Glucose is called dextrose while fructose is called levulose

As glucose is dextrorotatory while fructose is levorotatory

21. Cellulose is not digested by amylase

As it contains β Glucose and amylase is specific only for α linkage

22. Although cellulose is not digested yet it is important in our diet

As it increases the bulk of food so prevents against constipation

23. Hyaluronidase is present in the acrosomal cap of sperms

As the ova is surrounded by hyaluronic acid so the cap of the sperm contains hyaluronidase to help fertilization

24. Hyaluronidase is called spreading factor

As it is present in some bacteria & helps spread of infection

25. Glycogen is homopolysaccharide while heparin is heteropolysaccharide

As Glycogen is formed only of glucose while Heparin is formed of glucosamine bisulfate & uronic acid sulfate

26. Age related pains in old people

Due to replacement of hyaluronic acid by dermatan sulfate in synovial fluid Dermatan sulfate is not a good lubricant

27. Maltose is reducing while sucrose is non reducing

As maltose contains free anomeric carbon while sucrose doesn't

28. Products of glucose oxidation differ according to the strength of the oxidizing agent

Mild oxidation : Gluconic acid

Moderate oxidation : Glucuronic acid



Strong oxidation : Glucaric acid

29. Heparin is anticoagulant

As it binds & inactivates factors IX & XI & activates anti-thrombin III

30. Heparin is described as clearing factor

As it activates lipoprotein lipase removing lipids from plasma

31. Fructose is present in semen

As it is the only nutrient for sperms

32. Concentration of hyaluronic acid is increased during wound healing

As it is important for CT & present in intracellular cement substance

33. GAGs are important constituents of Extracellular matrix

As Heparin & heparin sulfate are bound to ECM proteins

34. Arachidonic acid may be essential

In absence of linoleic acid

35. Timnodonic may be essential

In absence in α linolenic

36. Palmitic & stearic acid are the most important FA

They are widely distributed in diet

37. Iodine No. is higher in oils than in fat

As oils are rich in USFA w` absorbs more iodine

38. Addition of vit. E , phenols & quinones may prevent oxidative rancidity

Vit. E , phenols & quinones are antioxidants so protects USFA against oxidation

39. Snake venom causes death

As it contains lecithinase, when injected into blood converts phospholipid in cell membrane of RBCs to lysophospholipid $\rightarrow$ Hemolysis

40. Testosterone is considered as a prohormone

As it is converted in tissues to dihydrotestosterone (DHT) w` is the most active androgen

41. β Carotene is important than α & γ Caroenes

As it gives 2 molecules of vit. A while α & γ Caroenes give only 1 molecule

42. Glycine is optically inactive

As it contains no asymmetric carbons

43. Amphoteric properties of Ptn.

As it reacts in acidic media as a base & carries +ve charges while in alkaline media reacts as an acid & carries -ve charges , this due to the presence of extra NH_2 & COOH groups

44. Denaturation causes many changes to Ptn.

Solubility decreases - viscosity increases - digestibility increases - Loss of function

45. Prolonged consumption of maize in absence of other protein leads to pellagra

As maize is difficient in niacin (vit. B3) & tryptophan



46. Collagen has a very firm structure

HEFS 2HE2FS

1. High content of glycine → The polypeptide chains are very close to each other
2. High content of hydroxyproline → Formation of hydrogen bonds
3. Each turn contains only 3 aa. residues → Tight helix
4. Formation of right handed superhelix
5. Formation of covalent cross links between the ϵ amino group of lysine or hydroxyl lysine e
allysine & hydroxylysine aldehyde
6. Specific arrangement into fibrils & fibers

47. With age collagen becomes less flexible

Due to increase the covalent cross links

48. Structure of aggrecans change e` age

As Keratan sulfate ↑ & Chondroitin sulfate ↓ & becomes shorter

49. Collagen forms left handed helix

Due to presence of proline w` is imino acid can't form hydrogen bonds

50. Distal histidine is of significant importance to heme

As it ↓ affinity to heme from 25,000 times to 200 times due to steric hindrance

51. Heme is related to 2 different histidines

Proximal histidine : form co-ordination bond e` Fe of heme

Distal histidine : See above

52. Oxygenation is co-operative process (oxygenation facilitates more oxygenation)

As Binding of O_2 to 1 of the polypeptide chains → rupture of 2 salt bridges → ↑ affinity of other subunits to O_2 so, when all subunits bind O_2 → rupture of 8 salt bridges & Hb is converted from T form to R form

53. 2,3 BPG is important in tissues

As it binds to Hb in tissues stabilizing the R form & help release of oxygen

54. Carbon monoxide is very toxic to the body

As • Carbon monoxide (CO) binds at O_2 binding site

- Affinity of Hb to CO is 200 times as that of O_2
- When CO binds to 1 or more of the 4 heme sites, Hb shifts to the relaxed form, so the remaining heme sites bind O_2 e` high affinity → Hb is unable to release O_2

55. Cyanide poisoning is treated by IV nitrite

As it converts Hb to Met Hb w` binds e` Cyanide forming cyan met Hb so it can be used in treatment of cyanide toxicity

56. Patient e` β thalassemia major appears normal at birth

Due to presence of Hb F ($\alpha_2\gamma_2$)

57. High levels of Hb F & Hb A₂ in patient e` β thalassemia

To compensate the absence of Hb A

58. Allopurinol is used in treatment of gout

As allopurinol (zyloril) is similar (structural analogue) to hypoxanthine, so it competes with hypoxanthine for the active site of xanthine oxidase → decrease uric acid formation & treats gout

59. Dicumarol (Warfarin) is anticoagulant :

As Dicumarol or (warfarin) is similar (structural analogue) to vit K, So it competes with vit K for the active site of vit K reductase → decrease the active form of vit K, so used as anticoagulant

60. CO & Cyanide are inhibitors for Cytochrome oxidase :

As Cyanide and CO block the Fe^{+2} of heme needed by Cytochrome oxidase, so stopping its action

61. Fluoride is important for estimation of blood glucose

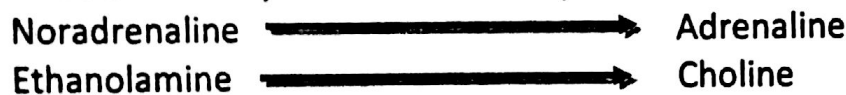
As fluoride binds Ca → inhibits blood clotting & also binds Mg → inhibits enolase which is important for glycolysis

62. cAMP is of great biological importance

As it acts as a hormone second messenger for many hormones as Glucagon & Epinephrine
أرسم من النظري

63. SAM & PAPS are free nucleotides of biological importance

As SAM acts as methyl donor in the body :



While PAPS acts as sulfate donor for synthesis of GAGs & Sulfolipid

64. Replication is said to be semiconservative

As replication results in 2 DNA molecules, each is composed of 1 parent (old) strand & 1 daughter (new) strand

65. Lagging strand is synthesized in a discontinuous manner

As DNA polymerases always read the template strand from 3' to 5' direction & synthesize a complementary strand from 5' to 3' direction so :

- The strand in the direction 3' to 5' is synthesized continuously & called leading
- The strand in the direction 5' to 3' is synthesized discontinuously & called lagging

66. Topoisomerases play an important role in replication

- Topoisomerase I : relieves +ve supercoils ahead of the replication fork
- Topoisomerase II : relieves the 2 interlocked double stranded circular DNA

67. Telomerase prevents chromosomal shortening

It is a ribonucleoprotein with reverse transcriptase activity, binds at the 3' of the template strand & uses the sequence AAUCCC as a template to synthesize a complementary dRNA TTAGGG so elongating the template DNA strand

68. σ factor has an important role to prokaryotic RNA polymerase

It binds to the core enzyme & enables it to bind with the template DNA strand

ρ (rho) factor may or may not be needed in prokaryotic transcription

- It may be needed in cases of ρ dependent termination ; when it binds to DNA strand & facilitates the dissociation of RNA Polymerase
- May not be needed in cases of ρ independent (intrinsic) termination

. Capping of the 5' end of the mRNA

1. Protects the 5' end from the action of 5' exonucleases
2. Important for initiation of translation by binding to cap binding Ptn
3. Directs the mRNA from the nucleus to the cytosol

1. Polyadenylation is an important mRNA post transcriptional processing

1. Protects the 3' end from the action of 3' exonucleases
2. Increases the $\frac{1}{2}$ life of mRNA
3. Increases the efficiency of translation

72. Splicing is an important mRNA post transcriptional processing

1. Alternative splicing results in formation of different types of mRNA
2. Decreases the risk of mutations

73. Some types of tumors develops resistance to treatment by methotrexate

- Methotrexate affects cancer growth by inhibiting dihydrofolate reductase (DHFR)
W' converts dUMP to dTMP needed for cancer growth
- Resistant bacteria amplifies DHFR gene increasing the amount of the enzyme

74. Some chromosomes are active while others may be inactivated

- Some chromosomes may be inactivated by Methylation of cytosine i.e. (Barr body)
- Others may be activated by Acetylation of the histones

75. Trimming may activate some proteins

As many proteins are synthesized in a large inactive forms (precursors) , they are Activated by removal of a part of the polypeptide chain by trimming

Preproinsulin $\longrightarrow$ Proinsulin $\longrightarrow$ Insulin

76. Mutations May occur spontaneously

This may occur by : Spontaneous deamination of cytosine into uracil

Spontaneous depurination by break down of its glycosidic bond

77. Sick cell anemia is an example for missense mutation

As in β globin gene , in nucleotide No. 17 A replaced by T

Sequence on coding strand GAG becomes GTG

Codon No. 6 GAG becomes GUG

aa No. 6 Glutamate replaced by Valine

This results in abnormal Hbs & leads to sickle cell anemia

78. Insertion or deletion of 1 or 2 nucleotides is more dangerous than that of 3 nucleotides

As Insertion or deletion of 1 or 2 nucleotides leads to change in the frame of reading & production of abnormal protein (Frame shift mutation)

79. There is a strict control on the cell cycle

Cell cycle control is done by certain regulatory proteins as :

1. Cyclin Dependent kinases "CDK" (1 to 6) ; phosphorylate regulatory proteins
2. Cyclins (A to E) binds to CDK & forms MPF
3. Cyclin Kinase Inhibitors (CKI) : P_{16} & P_{21} , inhibits CDK-cyclin complex

Restriction Point :

Point in the cell cycle (late in G1) at w` the cell become committed to enter S phase & to complete the cell cycle independent of the presence of growth factors

Also there are 3 checkpoints in the cell cycle ;

1. First checkpoint (G1 check point): Check for cell size , nutrient , growth factors & DNA damage
2. Second checkpoint (G2 checkpoint) : Check for cell size & DNA damage
3. Third checkpoint (Spindle assembly check point): Check that mitotic spindle is attached to all kinetochores

80. bcl-2 is a carcinogenic protein

As it binds & inactivates Bax protein so , it is anti apoptotic

81. Caspases are important enzymes during apoptosis

They are activated by apoptotic signal then they causes :

- Proteolysis (splits cellular proteins)
- Activates CAD (splits cellular DNA into fragments)

82. Functional importance of nucleosomes

Nucleosome is the simple unit of chromatin formed of a histone core (H2A , H2B , H3 & H4) & DNA It is important for :

- Packing of the DNA
- Regulation of gene expression by chromatin remodeling (methylation or acetylation)

83. For protein synthesis , 20 aa are utilized . They are capable of charging about 50 tRNA species . A charged tRNA may recognize more than 1 codon during translation

- 20 aa charge 50 tRNA : As some aa have more than 1 tRNA
- A charged tRNA may recognize more than 1 codon : This is due to Wobble theory
 - There is close apposition between the 1st 2 bases on mRNA & the corresponding 2 bases on tRNA
 - While there is no close apposition between the 3rd base on mRNA & that on tRNA (unusual base pairing) this allows some tRNA to recognize more than 1 codon

84. Saline is isotonic solution

As it has the same OP of that of body fluids 0.9 g% NaCl

85. By knowing the sequence of bases in DNA we can know the sequence of aa in Ptn & not t vice versa

Due to specificity (each codon specific only for 1 aa)



not the vice versa due to degeneracy (some aa may have more than 1 codon)

Poly A tail & 5' cap have a synergistic effect

Poly A tail binds to the 5' cap & form a circular structure that helps binding of mRNA to the ribosome (cap & tail have a synergistic effect)

. Give a short account on

Mechanisms of regulation of pH (factors regulating pH)

1. Buffers :

- 1st line of defense
- Acts in a fraction of a second (immediate response)

2. Respiration (Ventilation) :

- By $\uparrow$ or $\downarrow$ CO_2 excretion so regulates the amount of H_2CO_3 in the body

3. Kidneys :

- 2nd line of defense
- Slow process (takes several days to reach maximum capacity)
- By excretion of excess acids (H^+) or bases (HCO_3^-)

2. Buffers (definition , composition & enumerate physiological buffers)

Def. : Solutions w^h resist changes in their pH when moderate amounts of acids or bases are added

Composition :

1. A weak acid & its salt e^g strong base

- The weak acid (HA) is the proton donor & its conjugate base (A^-) is the proton acceptor
- pH of the buffer is less than 7 (Acidic buffer)
- The most common in physiological systems
- Examples : Carbonic / Na bicarbonate (H_2CO_3 / NaHCO_3)
Acetic acid / Na acetate (CH_3COOH / CH_3COONa)

2. A weak base & its salt e^g strong acid

- pH of the buffer is more than 7 (Basic buffer)
- Example : Ammonium Hydroxide / Ammonium Chloride (NH_4OH / NH_4Cl)

Physiological Buffers :

Function : Keep the PH of the blood and tissues around 7.4 w^h is suitable for the function of most body enzymes

Types :

1. Bicarbonate buffer system : mainly in Extracellular fluid
2. Phosphate buffer system : in all types of cells
3. Protein buffer system : in cells & plasma
4. Hemoglobin buffer system : in RBCs & Specific for buffering CO_2 Produced by oxidation in tissues



3. Importance of osmotic pressure

1. Regulation of volumes of different body fluids :

- There are 2 Forces that control the formation & reabsorption of the interstitial fluid
 - Capillary blood Pressure [Filtration force]
 - OP. of Plasma Proteins [Reabsorption Force]
- *At the Arteriolar end of the Capillaries :*
Capillary BP. > OP. of Plasma Ptns So Filtration occur
- *At the venular end of the Capillaries :*
OP. of Plasma Ptns > Capillary BP. So Reabsorption occurs
- In Hypoproteinemia ($\downarrow$ Plasma Ptns) Oedema may Occur *why..?*
 $\downarrow$ Plasma Ptns $\rightarrow$ $\downarrow$ OP. of Plasma Ptns $\rightarrow$ $\downarrow$ Reabsorption at the venular end of the capillaries $\rightarrow$ accumulation of fluids $\rightarrow$ Oedema
- So various body fluids are regulated by their contents of solutes i.e. ECF (blood) depends on Na while ICF depends on K

2. Urine Formation :

- Formation of urine starts e` filtration of the blood plasma through the glomerular capillaries into Bowman`s capsule w` is controlled by :
 - Capillary blood pressure [Filtration force]
 - OP. of plasma proteins [Reabsorption force]
- The volume of urine is affected by the concentration of Solutes in urine
- Some Diuretics act by $\downarrow$ Reabsorption of Na by renal tubules $\rightarrow$ $\uparrow$ its excretion in urine $\rightarrow$ $\uparrow$ urine volume
- In DM ; high concentration of glucose in urine $\rightarrow$ Polyurea ($\uparrow$ urine volume)

4. Racemic mixture

Def. : Solution Contains equal amounts of both enantiomers

- The optical activity of both isomers are antagonized $\rightarrow$ solution is optically inactive
- As solution contains equal amounts of D & L-glucose

5. Mesocompound

Def. : Compounds having asymmetric carbon atoms but optically inactive

- As one half of the compound is mirror image to the 2nd half
- That results in internal compensation of rotation
- Example : Mucic acid (oxidation product of galactose) is optically inactive

6. Hyaluronic acid

Repeating Units :

[D-Glucuronic acid + N-acetyl-D-Glucosamine]

Site : GV ISEZ

- Ground substance of Loose Connective tissue
- Vitreous humour of the eye
- Intacellular cement substance



- Synovial fluid
- Embryonic tissues
- Zona Pellucida of the ovum

Function :- Lubricant – Shock absorbant

- Important for cell migration & morphogenesis
- Its concentration is increased in cases of wound healing (repair)

- There is age related pains may develop in old people due to replacement of hyaluronic acid by dermatan sulfate in synovial fluid. Dermatan sulfate is not a good lubricant.

Hyaluronidase Enzyme (Spreading Factor) :

Site	Function
Some types of Bacteria	Hydrolyzes Hyaluronic acid present in the ground substance of connective tissue. So help spread of infection
Caps of Sperms	Helps Fertilization

7. Importance of GAGs & proteoglycans *CALCA*

1. Components of Extracellular matrix

2. Attact water by osmotic pressure into the Extracellular matrix causing swelling as GAGs w^h is present in proteoglycans are Polyanions → bind e⁻ cations like Na⁺ & K⁺, so attract water

3. Limit the passage of large molecules into Extracellular matrix allowing passage of small molecules; as they form gels at low concentration

4. Compressibility of cartilage

as cartilage is rich in proteoglycans w^h contain GAGs (polyanionic)

5. Aggrecan formation

- Aggrecan is the major proteoglycan present in cartilage
- Contains : *KCH*
 - Keratan Sulfate
 - Chondroitin Sulfate
 - Hyaluronic acid

6. Hyaluronic acid proteoglycan :

- Present in : Embryonic tissues
- Important for cell migration & morphogenesis
- Its concentration is increased in cases of wound healing (repair)

7. Heprin :

- Anticoagulant → as it ;
 - Bind factor IX & XI
 - Activates Antithrombin III

- Release the enzyme Lipoprotein Lipase (LPL) from the capillary wall to the Plasma, this enzyme helps removal of lipids from the blood So ; Heparin is called → Clearing factor "clears blood from lipids"

8. Keratan Sulfate proteoglycan : Important for transparency of the Cornea

9. Dermatan Sulfate proteoglycan : Important for Structure & Shape of Sclera of the eye

10. Heparan Sulfate proteoglycan :

- Present in Plasma membrane of cells
- Play important role in : Cell membrane receptors & Cell-Cell Interaction

8. Importance of Eicosanoids :

1. PGE_2 : → VD

→ Smooth Ms relaxant

2. $\text{PGF}_{2\alpha}$: → VC

→ Smooth Ms contraction

3. Thromboxane A_2 (TXA_2) : Synthesized by platelets & produces :

- VC
- ↑ Platelets aggregation

4. Prostacyclin I_2 (PGI_2) : Synthesized by vascular endothelium & produces :

- VD
- ↓ Platelet aggregation

5. Leukotriens : → ↑ Vascular permeability

→ Components of slow reacting substance of anaphylaxis (SRSA) → severe allergic reactions

6. Lipoxins → Anti-inflammatory

9. Rancidity

Def.: Development of bad flavor (odor & taste) of fats or oils

Causes : Exposure to **MOHM**

- **M**oisture – **O**xygen – **H**igh temperature – **M**etal (act as a catalyst)

Types : Hydrolytic & oxidative

1. *Hydrolytic Rancidity* :

Cause: Due to presence of

- Moisture (H_2O)
- Bacteria (Contain lipase enzyme)

- Lipase causes release of short chain FAs which are volatile
- Short chain FAs responsible for the bad odor & taste

2. *Oxidative Rancidity* :

- Oils are more liable to develop this type of ranciditywhy?

As : they are rich in USFA.

- Oxidation of USFA → Peroxides, ketones & aldehydes → Bad flavor



Addition of vit. E, phenols & quinones may prevent oxidative rancidity as they are antioxidants so protect USFA against oxidation

. Waxes

Def.: Esters of long chain FA with long chain alcohols

Site: Trunks of trees & fur of animals

Function: Acts as a protective coat

Examples:

1. True wax (Bee's wax) : Esters of palmitic acid & myricyl alcohol (C30)
2. Lanolin (in hair) : Esters of cholesterol derivatives
3. Vit A (Retinol) esters
4. Vit D (Calciferol) esters

11. Importance of Phospholipids *ALPHEC*

1. Arachidonic acid is provided from cell membrane phospholipid for synthesis of eicosanoids
2. Lung surfactants are dipalmitoyl lecithin
3. Platelet Activating Factor (PAF) is a choline plasmalogen
4. Hormone second messengers :

Activation of phospholipase C hydrolyzes phosphatidyl inositol bisphosphate (PIP₂) into :

- Inositol tris phosphate (IP₃) → ↑ intracellular Ca²⁺
- DAG → Activates protein kinase C

5. Emulsification of fat

6. Cell membrane & plasma lipoproteins

12. Importance of cholesterol

Formation of :

1. Cell membranes (Myelin sheath)
2. Bile salts (in liver)
3. Steroid hormones (in adrenals & gonads)

4. Vit D₃ (Cholecalciferol)

Cholesterol

7 dehydrogenase

Liver

7 dehydrocholesterol

Under skin
↓
UVR
↓
Vit D₃

13. Importance of bile salts : *MDAPS*

1. Main way for excretion of cholesterol
2. Digestion of fat due to emulsification



3. Absorption of fat due to formation of micelle
4. Prevents precipitation of cholesterol & formation of cholesterol stones
5. Stimulates liver cells to secrete more bile (Choleretic effect)

14. Amphoteric properties of aa.

Def. : In acidic media they react as bases & carry + ve charges & In alkaline media they react as acids & carry – ve charges

- Iso Electric point (IEP) :

Def. : pH at which the aa. Carries both – ve & + ve charges (Dipolar Ion) or (Zwitter Ion)

Occurs : at pH 6.02

At IEP : The aa can't migrate in electric field

- Amino acids accordingly may be present in 3 forms according to pH
- The uncharged form is not present any pH

15. Primary Structure :

Def. : No. & Sequence of aa. That form the backbone of the polypeptide chain

Maintained by : Peptide bond & Disulfide bond (if present)

Each polypeptide has 2 termini :

1. N-terminus : Free NH_2 group written on the left side
2. C-terminus : Free COOH group written on the right side

Shape : Ptn in the primary structure is in the form of a random coil

16. α - helix :

- The polypeptide chain is twisted into Rt. handed coil
- Each turn :
 - Length: 0.54 nm
 - Contains: 3.6 amino acids (so the length of each aa. is 0.15 nm)
- Maintained by : Hydrogen bond
- Each peptide forms 2 hydrogen bonds :
 - With the fourth peptide above
 - With the fourth peptide below
- Factors interfering with helix formation :
 1. Proline: Can't form hydrogen bond
 2. Many successive aa with bulky R as tryptophan
 3. Many successive acidic or basic aa as glutamate, aspartate, Arginine or lysine
- α -helix is hydrophobic due to intrachain hydrogen bonds
- Examples of α -helix includes : α keratin w^h is present in unstretched hair , Skin & na

17. Secondary structure of Ptn

Def. : Folding of the polypeptide chain into :

1. α - helix : See above
2. B-pleated sheets :

- Occurs between 2 or more extended polypeptide chains
- Maintained (stabilized) by : Hydrogen bond (interchains)
- 2 forms :
 - a. Parallel : Poly peptide chains runs in the same direction
 - b. Antiparallel : Polypeptide chains runs in opposite directions
- Example : β -keratin w^h is present in silk & stretched hair also amyloid ptn in Alzheimer disease (both contains antiparallel β -pleated sheets)

18. Tertiary structure :

Def: Twisting of the polypeptide chain to form a globular protein

Forces that stabilize the tertiary structure :

1. Hydrophobic interaction & Vander Waals forces between non polar R groups of aa.
2. Ionic or electrostatic interactions (salt bridges) between NH_3^+ of basic & COO^- of acidic aa.
3. Hydrogen bond between polar R groups.
4. Disulfide bond between 2 cysteines i.e. insulin & keratin

Domains : Large proteins contain 2 independently folded globular regions or domains. Each has its specific shape & function

19. Denaturation of Proteins :

Def.: Loss of the organization of ptn with breakdown of secondary , tertiary & quaternary structure if present.

Causes (Denaturing factors) :

a. Physical causes :

1. $\uparrow$ Temperature : rupture of weak bonds $\rightarrow$ denaturation
2. Repeated freezing & thawing

b. Mechanical causes :

Stirring & grinding

c. Chemical causes : *3S DR*

1. Strong acids or bases.
2. Solvent (organic ones)
3. Salts of heavy metals
4. Detergents
5. Reducing agents : Converts disulfide bond into SH

Changes due to denaturation :

1. Solubility $\downarrow$
2. viscosity $\uparrow$
3. Digestability $\uparrow$
4. Loss of function :



• Enzymes or hormones : loss of biological activities

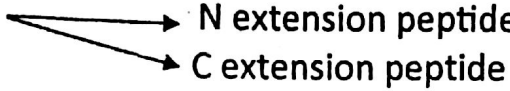
• Antigens : Loss of antigenic properties

20. Intra cellular reactions of collagen biosynthesis

1. Synthesis of procollagen α chains :

• By the ribosomes of rough endoplasmic reticulum

• Procollagen α chains contains :

- 2 extension peptides 
- Signal peptide

• The signal peptide directs the polypeptide chain into the endoplasmic reticulum

2. Conversion of procollagen α chain to procollagen α chain : By

• Removal of the signal Peptide by signal peptidase

• Hydroxylation of prolyl & lysyl residues by prolyl & lysyl hydroxylase (requires vit. C)

• Glycosylation of hydroxylysyl residues :

- Addition of glucose by glucosyl transferase
- Addition of galactose by galactosyl transferase

3. Formation of procollagen :

• Oxidation of cysteine residues & formation of disulfide bonds at the C terminal extension peptide & formation of triple helix

• Completion of glycosylation in Golgi apparatus

4. Exocytosis :

• Procollagen molecule is exocytosed outside the cell

21. Extracellular reactions of collagen biosynthesis

1. Formation of tropocollagen : By

• Removal of the N extension peptide by aminoproteinase

• Removal of C extension peptide by carboxyproteinase

2. Formation of interchain cross links :

• By lysyl oxidase (contains copper)

3. Formation of collagen fibrils & fibers :

• Tropocollagen molecules assemble in a staggered arrays into fibrils then packed to form collagen fibers

4. Maturation of collagen :

• By formation of intra & intermolecular cross linkages between lysine & hydroxy lysine

Action of lysyl oxidase & covalent cross links formation

• It causes oxidative deamination of ϵ amino group of lysine & hydroxy lysine , converting :

• Lysine $\longrightarrow$ Allysine (lysine ϵ aldehyde group)



• Hydroxylysine $\longrightarrow$ Hydroxy lysine aldehyde

- These aldehydes react with the ϵ amino group of unoxidized lysine or hydroxyl lysine forming intra & intermolecular covalent cross links

22. Biosynthesis of collagen

Answer of Q. 20 & 21

23. Marfan syndrome

Cause : Mutation of the gene encoding for fibrillin

Manifestations :

- Dislocation of the lens (ectopia lentis)
- Dilatation of the aorta
- Hyper extensibility of joints
- Patient is always tall & long digits

24. Cartilage proteins

A. Collagen Proteins :

- Collagen type II : 98 % of total collagen
- Minor forms of collagen : V , VI , IX , X & XI

B. Non collagenous proteins :

1. Proteoglycans (aggrecans) :

- Major proteoglycan of cartilage
- Consists of 3 types of GAGs : Keratan sulfate , Chondroitin sulfate & Hyaluronic acid
- Those 3 GAGs are attached to a core protein
- Have a bottle brush appearance

2. Large non aggregating proteoglycans

3. Chondronectin : Binds type II collagen

Organization of cartilage matrix :

- GAGs binds to collagen forming cross linked matrix
- GAGs are -ve charged , bind e^- cations & attract water $\longrightarrow$ Compressibility of cartilage
- Structure of aggrecans change with age as Keratan sulfate- Chondroitin sulfate & becomes shorter

25. Bone proteins

A. Collagen proteins :

- Collagen type I : 90 % of total collagen
- Collagen type V

B. Non collagenous Proteins :

1. Osteocalcin :

- Synthesized by osteoblast
- Major non collagenous matrix protein
- Vit. K : Mediates carboxylation of glutamate residue to γ carboxy glutamate that can bind Ca



- Calcitriol (active vit. D) : Induces its synthesis

2. Osteonectin : Glycoprotein , binds collagen & important for bone mineralization

3. Proteoglycans : Important for bone development & mineralization

26. Importance of apomyoglobin :

1. Prevents oxidation of heme into hematin (can't carry O_2) by formation of heme - O_2 - heme complex , apomyoglobin is important for reversible oxygen binding
2. Decreases affinity of heme to CO from 25,000 to 200
 - Heme has a higher affinity to CO than O_2
 - CO binds to myoglobin at the same binding site of O_2 → Myoglobin can't carry O_2
 - There is an angle between the 1st & 2nd oxygen atom about 121°
 - Distal histidine in apomyoglobin produces steric hindrance stabilizing O_2 binding & destabilizing CO binding
 - CO is produced in a very small amounts in the body from catabolism of Hb

27. Importance of globin :

1. makes heme soluble
2. Prevents diffusion of heme to plasma
3. Keeps iron in the ferrous state (as heme pocket is surrounded by non polar aa.)
4. Responsible for the sigmoid shape of O_2 dissociation curve

28. Changes that occur during transition of Hb from T to R form

• In absence of O_2 :

- Porphyrin ring is slightly carved
- Fe^{2+} lies above the plane of the ring by 0.04 nm

• Binding of O_2 causes :

- Porphyrin ring is flattened
- Oxygenation of Hb is associated with rupture of 8 salt bridges
- The 2 dimers rotate upon each other by 15°
- Pulling of Fe^{2+} to plane of the ring → pulls proximal histidine → pulls helix F → release of 2 protons from imidazole ring of histidine 146 of β chain & N terminal amino groups
- The liberated hydrogen ions bind to bicarbonate & forms carbonic acid that is broken by carbonic anhydrase to CO_2 (lost by the lungs) & H_2O

29. Role of 2,3 bisphosphoglycerate in oxygen delivery to tissues

- 2,3 BPG is a -ve charged molecule that binds to a +ve charged pocket in the centre of 4 H subunits
- Binding of 2,3 BPG → formation of more ionic bonds → favors T form

At tissues : low O_2 tension

Binding of 2,3 BPG stabilizes T form → release of O_2 → oxygenation

At lungs : High O_2 tension

Binding of $O_2 \rightarrow$ release 2,3 BPG $\rightarrow$ stabilize R form

30. Glycosylated hemoglobin (HbA1c)

- Glucose binds to the ϵ amino groups of lysine residues & to amino terminals of Hb.
- Rate of binding depends on the level of blood glucose.
- Range in normal persons & controlled diabetics 4 – 6.5 %
- If more than 6.5 % $\rightarrow$ Diabetic
- If more than 8 % $\rightarrow$ uncontrolled diabetes mellitus
- Used for follow up & not for diagnosis of diabetes mellitus

31. Sick cell anemia

- Genetic disease due to single nucleotide substitution (point mutation)
- aa. No.6 in β chain (glutamate) is replaced by valine
- Hydrophobic nature of valine produce ptn with marked tendency to form insoluble aggregates due to presence of sticky patches
- Polymerization is more in cases of deoxyhemoglobin due to presence of sticky patches on β subunits & their receptors on α subunits
- Patient may be :
 - Homozygous for sickle cell anemia : Contains Hb S only
 - Heterozygous for sickle cell anemia (sickle cell trait) : Contains Hb A & Hb S

Effects :

1. RBCs acquire the sickle shape
2. $\downarrow$ life span of RBCs (due to increase removal of sickled RBCs by spleen at a faster rate)
3. Frequent infarctions (aggregated RBCs block blood vessels) w` leads to localized anoxia , severe pain & even death
4. Individual become resistant to malaria due to $\downarrow$ life span of RBCs, parasite cannot complete its life cycle

32. Methemoglobinemia (Hb M disease)

- Genetic disease (Hereditary hemoglobin M)
- Proximal or distal histidine is replaced by tyrosine.
- $Fe^{2+} \rightarrow Fe^{3+}$
- Heme $\rightarrow$ Hematin
- Hb $\rightarrow$ met Hb $\rightarrow$ can't carry O_2

Other causes of methemoglobinemia :

Hemoglobin M may result normally in vivo from oxidation of Hb by :

1. Free radicals : H_2O_2
2. Drugs : Sulfonamides , nitrites & nitrates
3. Decreased activity of NADH met Hb reductase w` normally reverse the oxidation of Hb

33. Thalassemias

Hereditary hemolytic diseases due to gene mutation or deletions

A. α Thalassemias :

There are 4 α genes (2 on each chromosome 16)

a. Defect in 1 gene $\rightarrow$ carrier for α thalassemia

Symptoms : Complete normal (silent carrier)

b. Defect in 2 genes $\rightarrow$ α thalassemia trait

Symptoms : Mild anemia

c. Defect in 3 genes $\rightarrow$ α thalassemia major

Symptoms : Severe anemia

d. Defect in 4 genes $\rightarrow$ Homozygous for α thalassemia

Effects :- Dies intrauterine (Hydrops fetalis)

- Formation of abnormal Hb w^h have $\uparrow$ affinity to O_2 as Hb Bart (γ_4) & Hb H (β_4)

B. β thalassemias :

There are 2 β globin genes (1 on each chromosome 11)

a. Defect in 1 gene $\rightarrow$ β thalassemia minor (β thalassemia trait)

Symptoms : Mild anemia

b. Defect in 2 genes $\rightarrow$ β thalassemia major

Symptoms : Severe anemia later on after birth

Treatment : By blood transfusion

Prognosis : Dies before adulthood

34. Enzyme specificity.

- Enzymes are highly specific in their actions interacting e⁻ 1 (absolute specificity) or few related substrates (relative specificity)
- Enzyme specificity is due to the nature & arrangement of the chemical groups at the catalytic site
- Importance of enzyme specificity
 - Digestive enzymes are of low specificity allowing few No. of enzymes to digest all food stuff:
 - Metabolic enzymes are of high specificity to be well regulated

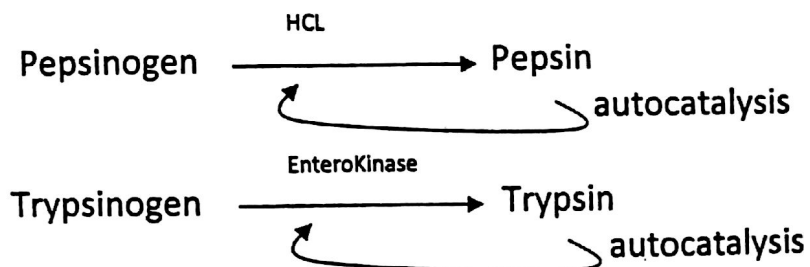
35. Zymogen (Proenzymes)

Def. They are enzymes secreted in an inactive form

- As the Active Site is masked by polypeptide chain

- Activated by removal of these polypeptide chain

Examples :- Digestive enzymes & enzymes of blood clotting



Isoenzymes (Isozymes)

Def :- Enzymes that catalyze the same reaction but differ in structure , properties & Rate of enzymatic activity

Properties :- They have different K_m , electrophoretic mobility & clinical uses

Example :-

a) Lactate dehydrogenase (LDH) which characterized by

- ✓ Formed of 4 polypeptide chains (subunits) either H or M
- ✓ So it has 5 Isoenzymes $LDH_{1,2,3,4,5}$
- ✓ LDH_1 is present in the heart & increased in MI
- ✓ LDH_5 is present in muscle & liver & increased in Ms & liver diseases

b) Creatine Kinase (CK)

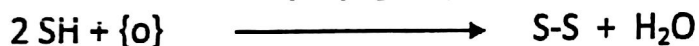
- ✓ Formed of 2 polypeptide chains either B or M
- ✓ So it has 3 isoenzymes $CK_{1,2,3}$
- ✓ CK_1 : BB → in brain & increased in brain infarction
- ✓ CK_2 : MB → in heart & increased in myocardial infarction
- ✓ CK_3 : MM → in Ms & increased in Ms diseases

37. SH (sulfhydryl) group inhibitors

- SH group is commonly found at the active site of many enzymes
- SH group inhibitors includes :-

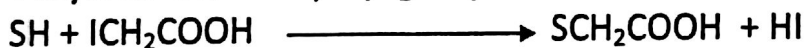
1. Oxidizing agents as K Ferricyanide

oxidizes the sulfhydryl group (SH) into disulfide (S-S)



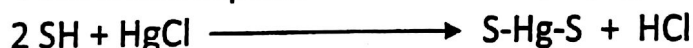
2. Alkylating agent as Iodoacetate :

Alkylates the sulfhydryl group



3. Salts of heavy metals as mercuric chloride

Forms mercaptide with the sulfhydryl group



38. OH group inhibitors

- SH group is commonly found at the active site of many enzymes
- SH group inhibitors includes :-

1. Aspirin : Produces acetylation of OH of serine of cyclo-oxygenase → ↓ PG synthesis → anti-inflammatory

2. Nerve gas (DFP) : Forms covalent linkages e` OH of serine of choline esterase → ↑ acetyl choline → laryngeal spasm

39. Chemical group inhibitors

See above Q. No. 38 & 39

40. Competitive inhibitors

- The inhibitor is similar to (structural analogue) to the substrate

- The I competes e` the S for the active site of the enzyme
- The inhibition can be reversed by increasing the conc. of the substrate
- K_m : increased & V_{max} : no effect
- Examples :
 1. Allopurinol is competitive inhibitor to xanthine oxidase $\rightarrow$ $\downarrow$ uric acid & treats gout
 2. Malonate is competitive inhibitor to succinate DH
 3. Warfarin & dicumarol are anticoagulants as they are competitive inhibitors to vit. K reductase
 4. Sulfonamide is antibiotic as it $\downarrow$ folic acid formation in bacteria
 5. Methotrexate is anticancer as it is competitive inhibitor to DHFR $\rightarrow$ $\downarrow$ folic acid

41. Allosteric inhibitors

- Enzymes contain certain site known as allosteric site
- Binding of organic modifier to the allosteric site may produce conformational changes in the active site $\rightarrow$ decreasing the affinity of the enzyme to the substrate
- K_m : $\uparrow$ & V_{max} : $\downarrow$
- Feed back inhibition :
 - Type of allosteric inhibition
 - The end product of a series of reactions inhibits an enzyme early in the pathway
 - K_m : increased & V_{max} : decreased

42. Mitochondrial DNA (mtDNA)

% : 0.3 – 1 % of total DNA

Shape : Circular double stranded DNA

Inheritance : Maternally inherited

Function : Formation of 22 tRNA , 13 Ptn & 2 rRNA (for oxidative phosphorylation)

Defect : Leads to myopathies

43. G protein

- Transmembrane protein formed of 3 subunits α , β & γ
- In the resting state α subunit is attached to GDP
- When a hormone binds to the receptor G protein bind to the receptor then,
- GDP is replaced by GTP
- α GTP is released either activates αs or inhibits the enzyme αi
- α subunit has GTPase activity , when the hormone is release GTP is hydrolyzed to GDP
- α GDP rebind e` β & γ returning to the resting state
- Examples of enz. Activated through G protein : Adenylate cyclase – Phospholipase c

44. Function of RNA

RNA is concerned e` Ptn synthesis ; each type has a role :

mRNA : Carries the message from DNA in the nucleus to ribosomes in cytoplasm

tRNA : Carries the aa needed for Ptn synthesis

i Ptn synthesis according to the message provided by mRNA & by the help of



aa carried on tRNA

Initiation of replication

In prokaryotes :

- Starts at an area called ori (rich in A – T base pairs)
- dna A recognizes the ori & begins separating the 2 strands
- dna B (helicase) & dna C bind together & forms a complex w^h binds to dna A
- Helicase forces itself between the 2 strands separating it this requires energy
Provided by hydrolysis of ATP
- SSBP binds to single stranded DNA preventing the rebinding of the 2 strands

b. In eukaryotes : As in prokaryotes but there are multiple oris forming multiple replication forks

6. Telomere & telomerase or (Telomere ; function & associated problems)

Telomere is a non coding sequence at the end of the chromosome consists of tandem repeats of TTAGGG , it causes 2 problems :

- 1st : It looks like chromosomal break , so it may cause chromosomal recombination this problem is solved by :
 - The 3' end of the chromosome always overhangs the 5' end
 - So , it is folded over itself , binds the 5' end & attaches to Ptns preventing chromosomal recombination
- 2nd : A problem w^h the lagging strand , as primase can't work at the very end of the chromosome & this may lead to chromosomal shortening this problem is solved by telomerase
 - It is a ribonucleoprotein w^h reverse transcriptase activity , binds at the 3' of the template strand & uses the sequence AAUCCC as a template to synthesize a complementary dRNA TTAGGG so elongating the template DNA strand & preventing shortening of the chromosome

47. Mis match repair

Aim : correction of copying errors (2-5 improper bases)

Steps :

- Recognition of the lesion by certain proteins that scan the DNA for any defect
- The old strand is recognized by presence of methylated adenine
- Endonuclease : Cuts the damaged strand at the site of lesion
- Exonuclease : Removes the mutated base
- DNA polymerase ϵ : Fill the gap by the right base
- Ligase : Seals the nick

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48. Function of σ (sigma) factor & ρ (rho) factors in prokaryotic transcription

σ factor binds to RNA polymerase (core enzyme) & help it to recognize the promoter while ρ factor may be needed in termination of transcription

49. Post transcriptional processing (modification) of mRNA

- a. Capping : at the 5' end by 7 methyl GTP
 1. Protects the 5' end from the action of 5' exonucleases
 2. Important for initiation of translation by binding to cap binding Ptn
 3. Directs the mRNA from the nucleus to the cytosol
- b. Polyadenylation : addition of poly A tail at the 3' end
 1. Protects the 3' end from the action of 3' exonucleases
 2. Increases the $\frac{1}{2}$ life of mRNA
 3. Increases the efficiency of translation
- c. Splicing : cutting of the introns & joining of the neighboring exons
 - Done by spliceosome w^h is ribozyme formed of snRNA attached to Ptn
 - Importance :
 1. Alternative splicing results in formation of different types of mRNA
 2. Decreases the risk of mutations
- d. mRNA editing : Changing the coding information of mRNA
 - apo B gene in liver transcribed $\rightarrow$ mRNA $\rightarrow$ complete translation $\rightarrow$ apoB₁₀₀
 - apo B gene in intestine transcribed $\rightarrow$ mRNA $\rightarrow$ translation of 48 % $\rightarrow$ apoB₄₈
due to conversion of CAA to UAA (stop codon) by cytidine deaminase

50. Lac operon (lactose operon of E. coli)

Operon : Linear array of genes involved in a metabolic pathway

Lac operon is formed of :

1. Structural genes :
 - Z gene : codes for β galactosidase (lactase)
 - Y gene : codes for galactoside permease (lactose permease)
 - A gene : codes for thiogalactoside transacetylase
 2. Operator : site of binding of the repressor
 3. Promoter : site of binding of RNA polymerase
 4. I gene (regulatory) : codes for the repressor ptn
 5. Cap site for binding e⁻ cAMP
- In presence of glucose & absence of lactose the repressor Ptn binds e⁻ the operator & prevents transcription of the Z, Y & A genes (Repression)
 - When glucose & lactose are present : Expression of lac operon is negligible (No cAMP)
 - when lactose is the only sugar : lactose binds e⁻ the repressor Ptn preventing it from Binding e⁻ the operator & cAMP is bound to cap site, so RNAP transcribes Z, Y & A genes (Derepression or induction)

ارسم من النظري

51. Gene alteration (DNA modification)

I. Amount of DNA

- a. Gene amplification : Increasing the No. of genes



1. In histones & rRNA genes
2. In methotrexate resistant bacteria :
 - Methotrexate affects cancer growth by inhibiting dihydrofolate reductase (DHFR) w` converts dUMP to dTMP needed for cancer growth
 - Resistant bacteria amplifies DHFR gene increasing the amount of the enzyme
- b. Gene diminution : Removing a gene or genes from the genome i.e. loss of genes of RBCs
- i. Gene rearrangement or recombination : i.e. antibody diversity

Cis acting elements

Def. : Specific DNA sequence responsible for regulation of gene expression

- a. Enhancers : Increase rate of gene expression
- b. Silencers : decrease rate of gene expression
- c. HRE (hormone response elements) : mediate the response of the hormones
- d. Tissue specificity elements : Express certain genes only in certain tissues

3. Trans acting regulatory proteins

- Regulatory Ptns e` specific motifs that bind e` regulatory Ptns activating transcription as :
 - CTF binds e` CAAT box → activating transcription
 - TAF binds e` TFIID → activating transcription

54. Regulation of transcription in eukaryotes

- a. Chromatin remodeling (access to DNA)
 1. methylation of cytosine
 - Some chromosomes may be inactivated by Methylation of cytosine i.e. (Barr body)
 2. Acetylation of histones
 - Chromosomes may be activated by Acetylation of the histones
- b. DNA regulatory regions
 1. Basal expression elements : CAT , TATA & GC box
 2. Cis acting elements : سؤال رقم 52
 3. Trans acting elements سؤال رقم 53
- c. DNA regulatory factors : Ptn factors having more than 1 binding domain
 1. DNA binding domain
 2. Transcription activating domain
 3. Anti repressor domain
 4. ligand binding domain

55. Regulation of initiation of translation

1. IF2 : Phosphorylated by Ptn kinases , when phosphorylated inhibits formation of 43S preinitiation complex
2. IF4 (cap binding Ptn) : • It helps the mRNA to bind e` 43S preinitiation complex
 - Has ATPase helicase activity (unwind mRNA)
 - Phosphorylated by insulin & mitogenic growth factor , when Phosphorylated it enhance the initiation

3. Poly A tail binds to the 5' cap & form a circular structure that helps binding of mRNA to the ribosome (cap & tail have a synergistic effect)

56. Regulation of gene expression in eukaryotes

a. Gene alteration : سؤال رقم 51

b. Regulation of transcription سؤال رقم 54

c. Post transcriptional regulation :

1. Alternative splicing as :

- calcitonin gene

• Splicing all exons in thyroid gland gives calcitonin hormone

• Splicing only some exons in neurons gives a Ptn involved in taste

- Alternative splicing of tropomyosin gives rise to 7 isoforms

2. RNA stability : The longer the poly A tail the longer the $\frac{1}{2}$ life of mRNA

3. mRNA editing : Changing the coding information of mRNA

d. Regulation of translation سؤال رقم 55

57. Characters of genetic code

1. Specificity : Each codon only codes for 1 aa

2. Universality : Applied for all living organisms

3. Degeneracy :-Some aa having more than 1 codon (synonym codons)

some tRNA may recognize more than 1 codon : This is due to Wobble theory

- There is close apposition between the 1st 2 bases on mRNA & the corresponding 2 bases on tRNA

- While there is no close apposition between the 3rd base on mRNA & that on tRNA (unusual base pairing) this allows some tRNA to recognize more than 1 codon

4. Reading frame : Always start by recognition of AUG (initiating codon)

Genetic code is uninterrupted & unoverlapped

58. Aminoacyl tRNA synthetase (Charging of aa on tRNA)

• It binds the aa to its specific tRNA , there is at least 1 specific tRNA for each aa

• Also there is at least 1 specific aminoacyl tRNA synthetase for each aa

• It recognizes the aa by the R radical & the tRNA by the anticodon & D loop

+ أرسم المعادلة

59. Base substitution mutation (point mutation)

Types : Transition : Purine replaced by purine or pyrimidine replaced by pyrimidine

Transversion : Purine replaced by pyrimidine or pyrim. replaced by purine

Effects : Mis sense , Non sense or silent mutation

a. Mis sense mutation : A type of substitution (Point) mutation in which there is permanent change in one nucleotide leads to change of the codon on mRNA leads to change of the aa in protein product of the gene

Example : Sickle cell anemia

in β globin gene , in nucleotide No. 17 A replaced by T

Codon No. 6 GAG becomes GTG
aa No. 6 Glutamate replaced by Valine

This results in abnormal Hbs & leads to sickle cell anemia

- b. Non sense mutation : A type of substitution (Point) mutation in which there is permanent change in nucleotide leads to change of the codon on mRNA & the resulting codon is stop codon UGA , UAG or UAA resulting in premature termination of translation
- c. Silent mutation : A type of substitution (Point) mutation in which there is permanent change in one nucleotide leads to change of the codon on mRNA & the resulting codon codes for the same aa (synonym codon) so there is no change in the protein product of the gene

60. Phases of cell cycle

P31 : mention Q No. 318

61. Control of cell cycle

P 44 : explain why Q No.79

62. Apoptosis (Definition – mechanism & importance)

Def. : Programmed cell death

Mechanism :

1. Cell death pathway (extrinsic) or receptor mediated apoptosis : ligand bind e` death receptor (TNFR or Fas R.) → through caspase 8
2. Mitochondrial pathway (intrinsic) or unrepairable DNA damage : Activates P53 w` activates Bax gene w` produces Bax ptn w` induces apoptosis → through caspase 9

Initiation of apoptosis involving the following cascade

- Either mechanism 1 or 2 leads to intracellular signal w` activates proapoptotic Ptn
- Then release of mitochondrial cytochrome C w` activates Caspases
- Caspases cause :
 - Proteolysis (splits cellular proteins)
 - Activates CADase (splits cellular DNA into fragments)

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Biochemistry (regulation of apoptosis) by :

1. Caspase :

- Pre-existing in the cell in an inactive form
- 2 types of caspases
 1. Initiator (upstream) caspase : Activated by apoptotic signal & activates effector caspase
 2. Effector (downstream) caspase : Present in the form of zymogen & activated by its cleavage at aspartate (autoactivation)

2. BCL₂ family :

- Apoptotic : BAX , BAK & BOK
- Anti-apoptotic : BCL₂ & BCLx

3. Inhibitors of apoptosis proteins (IAP) : Inhibits apoptosis

Application of apoptosis : *ECMAAT*

1. Emryonic development
2. Cancer
3. Menstrual cycle
4. Aging
5. Autoimmune diseases
6. Thymus atrophy

Apoptosis & diseases :

1. Nervous system : Amyloid Ptn in Alzheimer disease induces apoptosis of nerve cells
2. Immune system :- Defect in apoptosis leads to autoimmune disease
 - Immune cells should be resistant for apoptosis
3. Cancer : Cancer cells may express anti-apoptotic protein i.e. BCL2
4. Apoptosis modulating therapy : Some drugs may ↑ or ↓ apoptosis

63. Restriction Endonucleases

- Bacterial enzymes
- Restrict the growth of viruses inside the bacteria by cutting viral DNA (Endonucleases)
- Bacterial DNA is protected by methylation
- Cut the DNA at a certain palindrome (restriction sequence)
- Resulting DNA fragments are called restriction fragment either have
 - Sticky or staggering ends
 - Blunt ends
- Examples ECoR I & Mst II
- Used in recombinant DNA technology to produce chimeric molecules also in restriction maps

64. Requirements for PCR *TD TD B*

1. Two DNA primers
2. Deoxyribonucleoside triphosphate (dATP , dGTP , dCTP & dTTP)
3. Thermostable DNA polymerase (taq polymerase)
4. DNA to be amplified
5. Buffer solution

65. Steps & application of PCR

Def. In vitro method for DNA amplification

Steps : *Heating Cooling Heating*

- a. Denaturation : Heating to 95° C
- b. Primer annealing : Cooling to 55° C
- c. Elongation : Heating to 72° C allowing taq polymerase to elongate the primers

applications of PCR : *2S 2D F*



1. Synthesis of DNA for cloning
 2. Synthesis of proteins : Insulin – GH – Vaccines
 3. Diagnosis of genetic diseases
 4. Detection of bacterial & viral infection i.e. HIV & hepatitis B
 5. Forensic medicine : amplification of DNA from hair or sperm
6. Is there any situation in which DNA is made based on a RNA template? What is the enzyme involved?
1. for solving the problem of shortening of the telomere : by telomerase
(اشرح من سوال رقم 46 ص 59)